THE STATE OF TOKENIZATION AND REAL WORLD ASSETS

MID 2025

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The State of Tokenization and Real World Assets (RWAs) – Mid-2025

Executive Summary

Tokenization of real-world assets (RWAs) has entered a phase of rapid growth and institutional acceptance as of mid-2025. After years of experimentation, the market for tokenized assets (excluding stablecoins) has surged to around $13–15 billion, up over 60% in 2024 alone [marketsmedia.com]. This momentum is driven by a confluence of factors: improving regulatory clarity, mature blockchain infrastructure, and the entry of financial giants. Industry forecasts now project that trillions of dollars of assets could be on-chain by 2030, ranging from $2–5 trillion in conservative scenarios to $16 trillion (10% of global GDP) in more bullish outlooks [thetokenizer.io]. In short, tokenization is more relevant now than ever, poised to transform capital markets by unlocking liquidity and access to traditionally illiquid assets.

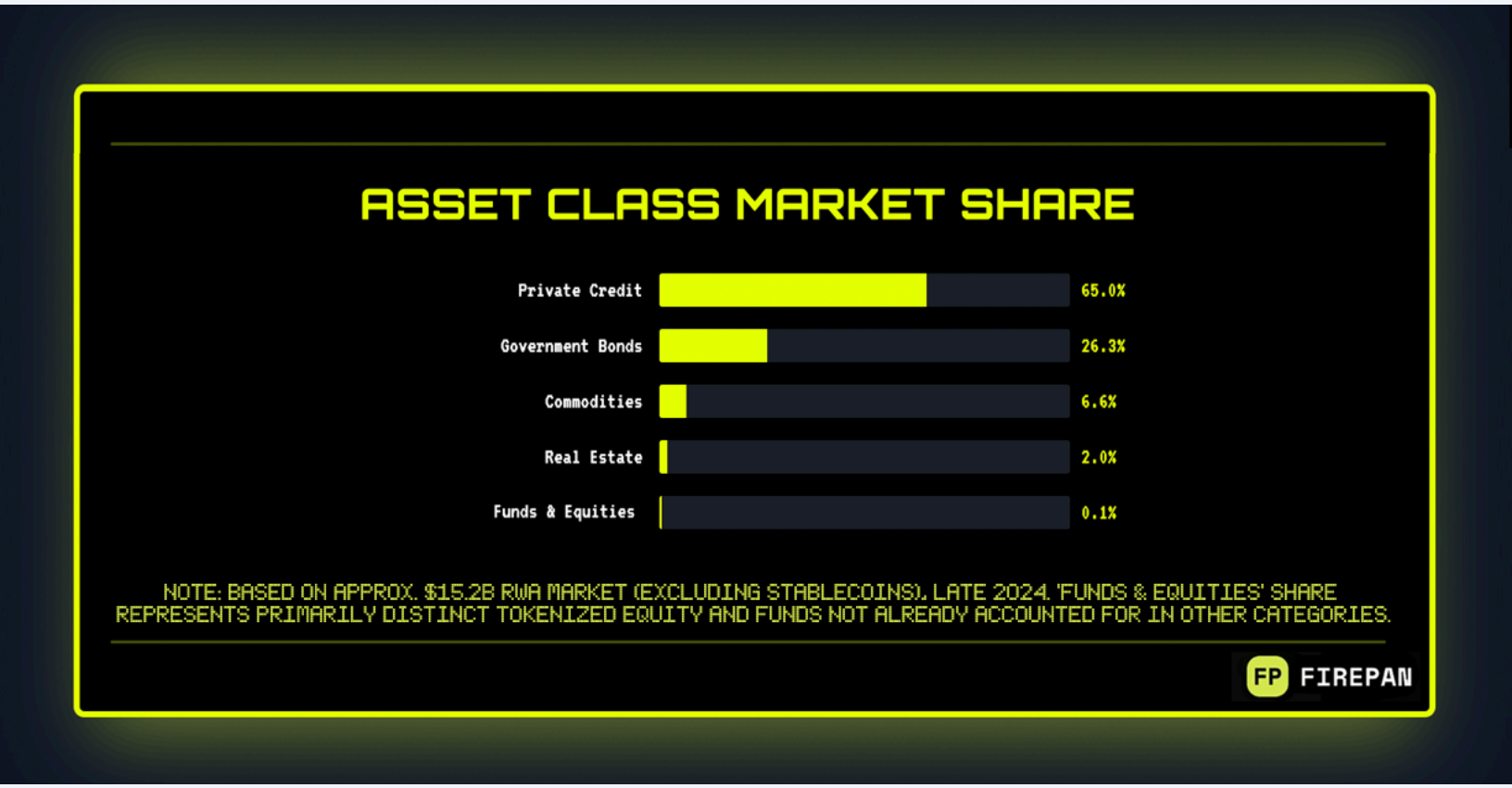
Major financial players are catalyzing this shift. BlackRock's CEO Larry Fink recently declared that "the next generation for markets…is the tokenization of securities," underscoring a broad industry vision [finance.yahoo.com]. In the past year, household-name institutions – from BlackRock launching tokenized funds to JPMorgan using blockchain for $300+ billion in repo transactions – have demonstrated real-world use cases at scale. Key statistics highlight this momentum: for example, on-chain tokenized U.S. Treasuries tripled from $760 million to $2.6 billion during 2024 [marketsmedia.com] as investors sought on-chain yields, and tokenized money market funds quickly amassed over $1 billion in value by Q1 2024 [mckinsey.com]. These developments signal that tokenization is no longer theoretical; it is happening now, with tangible results.

Looking ahead, RWAs are positioned to become an integral part of the digital asset ecosystem and a cornerstone of modern finance. This report provides a high-level overview of the market's current state and recent acceleration, while also diving deeper into the market landscape, emerging trends, technology infrastructure, regulatory regimes, institutional case studies, and the challenges that must be addressed.

Firepan will help play a role in this evolving ecosystem and present a forward-looking outlook toward 2030. In aggregate, the findings show that tokenization is shifting from pilot projects to production deployments, setting the stage for a more accessible, efficient, and global financial system.

Market Landscape & Trends

The tokenized asset market has expanded dramatically and is now a multi-billion-dollar segment. As of late 2024, the on-chain RWA market (excluding stablecoins) reached over $15 billion, an ~85% year-over-year increase [investax.io]. (Including stablecoins – tokenized cash – the figure exceeds $200B, though this report focuses on non-currency assets [investax.io]. Growth has been broad-based across asset classes, signaling increasing adoption in diverse sectors. Analysts at Coinbase note that tokenized RWAs grew 60% in 2024, from $8.4B at end-2023 to about $13.5B by December 2024 [marketsmedia.com], far outpacing the broader crypto market growth. This acceleration is expected to increase through 2025, making tokenization one of the fastest-growing trends in fintech.



Early tokenization activity has clustered in certain asset classes, though diversification is underway:

- **Private Credit:** Tokenized private debt is the single largest category, making up roughly 65% of the RWA token market in 2024 [investax.io]. This includes

tokenized loans, trade finance, and other credit products. A significant driver is Figure (on the Provenance blockchain), a fintech lender whose ~$8.8 billion in on-chain loan balance accounts for over 90% of on-chain private credit volume [marketsmedia.com]. In short, private credit has led RWA growth by bringing traditionally illiquid loans on-chain at scale.

- **Government Bonds (Treasuries):** Tokenized sovereign debt – especially U.S. Treasuries – saw explosive growth in 2023–2024 amid rising interest rates. Tokenized U.S. Treasury products crossed $4 billion in value by the end of 2024 [investax.io]. On-chain Treasuries grew more than 3× in 2024 (from ~$760M to $2.6B by Dec) driven by new tokenized treasury funds like BlackRock's and others [marketsmedia.com]. These on-chain treasuries offer institutional and crypto-native investors convenient access to 5%+ yield on a secure asset, explaining their rapid adoption [investax.io].

- **Funds and Equities:** A number of tokenized funds (private equity funds, money market funds, etc.) have launched, contributing to the private credit and bond figures. For example, tokenized money market funds (MMFs) are projected to reach $400B in size by 2030 [citigroup.com] as they provide 24/7 liquidity and faster settlement for cash management. Tokenized equity (stocks) is less common so far, due to regulatory hurdles, but there are pilots in private markets and fractionally-owned shares.

- **Real Estate:** Tokenized real estate is an emerging segment, including both commercial properties and real estate investment funds. While currently a smaller slice of the market (in the hundreds of millions of dollars), real estate tokenization volume grew ~28% year-on-year, according to Firepan's market highlights [firepan.com]. Projects have ranged from tokenized REIT shares to fractional ownership of individual buildings. Real estate remains poised for growth as legal frameworks catch up, given the sheer size of global property markets.

- **Commodities:** Tokenized commodities (e.g. gold, metals, energy) surpassed $1 billion in aggregate market cap in 2024 [investax.io]. Gold-backed tokens are the standout, led by Pax Gold (PAXG) which alone reached a ~$530M market cap [investax.io]. Tokenized gold offers investors the ability to hold and transfer physical gold exposure on blockchain with ease. Other commodities like silver, oil, and agricultural goods are earlier in experimentation, while carbon credit tokens have begun trading (with ~45% growth in Q2 per Firepan data [firepan.com] as part of ESG and climate-related finance.

Virtually every major financial research house now agrees tokenization will unlock significant value by 2030, though estimates vary. Boston Consulting Group (BCG), in partnership with ADDX, famously projected a $16 trillion tokenized illiquid asset market by 2030 (~10% of global GDP) [ledgerinsights.com]. This headline number underscores the transformative potential if even a fraction of real estate, private equity, bonds, etc. move on-chain. Other forecasts are more conservative but still dramatic: Citi analysts expect up to $4 trillion of tokenized assets (mainly in private markets) by 2030, implying an ~80× growth from 2022 levels [thetokenizer.io]. 21Shares research predicts at least $5 trillion by 2030, calling 2025 a breakout year for tokenization. Coinbase's 2025 outlook suggests RWA tokenization could reach *"$2 trillion on the low end to $30 trillion on the high end in the next 5 years,"* reflecting both minimum expectations and an optimistic scenario [marketsmedia.com]. While the wide range indicates uncertainty, the common theme is that trillions of dollars in value are likely to be represented on blockchains within this decade.

Several important trends are emerging in the RWA tokenization space, influencing how the market develops:

- **Interoperability and Multi-Chain Connectivity:** Early RWA initiatives often launched on siloed platforms or single blockchains, but 2025 has seen a push toward cross-chain interoperability. For instance, projects under Singapore's Project Guardian demonstrated trades of tokenized assets across multiple blockchains: JPMorgan's Onyx and Apollo conducted a POC where assets on a permissioned network (Provenance) were interoperably traded using the Axelar protocol to bridge to other chains [businesswire.com]. Likewise, tokenization platform Securitize is leveraging the Wormhole protocol to make tokenized funds available on six different blockchains simultaneously [ledgerinsights.com]. This trend addresses a key need for liquidity – allowing tokens to move to where the buyers are – and points toward a future where no single blockchain dominates. Standards like the Inter-Blockchain Communication (IBC) protocol and projects like Polkadot are also contributing to a more interconnected tokenization ecosystem.

- **Compliance Automation and Identity Integration:** Given that RWAs are regulated securities or assets, ensuring compliance (investor eligibility, transfer restrictions, etc.) is paramount. A major trend is embedding compliance logic *on-chain* ("compliance by code"). New token standards such as ERC-3643 (the T-REX standard developed by Tokeny) allow identity verification and transfer permissions to be built directly into tokens [chainalysis.com]. This means only KYC/whitelisted wallets can hold or trade a token, and unlawful transfers can be automatically blocked – all enforced by the smart contract. Similarly, ERC-1400,

an earlier security token standard, introduced features like partitioned ownership tranches and forced transfers to support regulatory requirements [polymath.network] . We are seeing widespread adoption of these compliance-first standards, and tools like on-chain identity attestations and credential wallets are gaining traction. Coinbase reports that many tokenized U.S. Treasuries today meet compliance needs by *“handling KYC off-chain and whitelisting known wallets,”* but predicts that more elegant on-chain verification will *“improve meaningfully in 2025”* as decentralized identity solutions mature [marketsmedia.com]. In short, regulatory compliance is increasingly being automated through smart contracts, reducing manual processes.

- **Asset Origination Innovation:** Another trend is innovation in how assets are originated and brought on-chain. Tokenization is enabling new fundraising and securitization models. Smaller originators can fractionalize assets to reach global investors, and large institutions can disaggregate portfolios into investable tokens. A prime example is Figure Technologies, which started as a lending platform and expanded into an on-chain marketplace for loans. Figure’s use of the Provenance blockchain to originate and trade loans has shown that even

traditionally illiquid assets like home equity lines can achieve scale on-chain (Figure's ~$8.8B in active loan tokens illustrates this) [marketsmedia.com]. Additionally, tokenization platforms are streamlining issuance – assets like invoices, trade finance deals, revenue-sharing agreements, and more are being packaged into tokens and funded via both DeFi and traditional channels. This is spurring creativity in product design, such as NFTs representing individual real estate properties or music royalties, which can then be bundled or used as collateral in DeFi. The ability to *program* assets (with cash flows coded into smart contracts, for example) is another layer of innovation, allowing automated interest distributions, on-chain refinancing, and other novel features that weren't possible before.

- **Liquidity Solutions & Secondary Markets:** While initial token offerings are increasing, liquidity for these tokens remains a challenge that the industry is actively addressing. We observe growth in both centralized and decentralized secondary markets for RWA tokens. Regulated security token marketplaces like Securitize Markets, ADDX, and Oasis Pro are providing venues for accredited investors to trade tokenized securities under regulatory oversight. At the same time, on the DeFi side, protocols such as Centrifuge and MakerDAO are facilitating liquidity by letting tokenized real-world assets serve as collateral for loans or be pooled into interest-bearing instruments. For example, Centrifuge's decentralized Tinlake platform lets investors fund pools of tokenized invoices or real estate loans, and recently Centrifuge even launched a tokenized U.S. Treasury fund (Janus Henderson Fund), bringing TVL to ~$437M in 2025 [nftgators.com]. Market participants are also exploring automated market makers (AMMs) and liquidity pools for continuous trading of RWA tokens, though low volumes and regulatory constraints make this nascent. Another liquidity-focused development is tokenized assets being used in repos and derivatives – for instance, JPMorgan Onyx's tokenized collateral network (discussed below) allows instant pledging of tokenized funds for margin, improving liquidity usage [ledgerinsights.com]. In summary, to prevent tokenized assets from simply being "digitized but illiquid," the industry is working on a range of liquidity solutions from exchanges to DeFi integration, which will bolster the overall tokenization value proposition.

Collectively, these trends indicate that the RWA tokenization market is not only growing in size but also maturing in functionality. The focus is shifting from *"can we tokenize X?"* to *"how do we efficiently integrate tokenized assets into the financial system?"* Market infrastructure is evolving to connect disparate blockchain networks, enforce compliance automatically, originate new asset types, and enable active trading. The following

sections will examine the technology stack enabling these trends, the regulatory frameworks shaping them, and real-world adoption examples that illustrate the state of the industry.

Technology Stack & Infrastructure

Tokenizing real-world assets requires a multi-layer technology stack that ranges from base-layer blockchains up to application-layer platforms. This section describes the key components of that stack – including the blockchains (Layer-1s and Layer-2s) being used, the role of permissioned chains, smart contract standards, and the middleware and platforms enabling token issuance.

A variety of blockchain networks serve as the settlement layer for RWA tokens. Ethereum remains the dominant base for tokenization, thanks to its developer mindshare and robust smart contract capabilities. Many tokenized assets are issued as ERC-20 or ERC-1400 tokens on Ethereum or Ethereum-compatible chains. However, due to Ethereum's congestion and fees, alternative Layer-1s and Layer-2 networks have risen in popularity for RWAs:

- **Polygon (Ethereum sidechain/L2):** Offers lower cost and faster throughput while inheriting Ethereum's security (in the case of Polygon zkEVM or PoS sidechain). Polygon has attracted notable RWA projects – for example, Franklin Templeton's OnChain U.S. Government Money Fund is now supported on Polygon, bringing a regulated $380 million money market fund on-chain via Polygon's network [cryptoslate.com]. Polygon's ecosystem and EVM compatibility make it a go-to choice for tokenized funds looking to reach Ethereum's liquidity with fewer fees.

- **Avalanche:** With high throughput and subnetwork architecture, Avalanche has been used in several high-profile tokenizations. Securitize chose Avalanche's C-Chain for tokenizing a KKR private equity fund in 2022, citing its speed and cost advantages [coindesk.com]. Avalanche subnets allow the creation of app-specific chains, which some institutions are exploring for dedicated RWA platforms that still benefit from Avalanche's consensus security.

- **Stellar:** A payment-focused L1 known for low cost transactions, Stellar was an early choice for Franklin Templeton's fund (initially launched on Stellar in 2019) and other tokenized money markets. Stellar's built-in compliance features (like account whitelisting) and reliability have appealed for certain financial assets.

Franklin's fund now operates on both Stellar *and* Polygon, reflecting a multi-chain approach [cryptoslate.com].

- **Other L1s:** Algorand, Tezos, and Solana have also seen some RWA token launches (e.g., tokenized real estate or art on Algorand, digital bond experiments on Tezos), though not yet at the scale of Ethereum/Polygon. BNB Chain has hosted some tokenized real estate offerings targeting retail investors in Asia. As RWA activity grows, we expect a continued plurality of L1s – issuers will choose networks based on transaction costs, speed, and ecosystem, while possibly issuing the same asset on multiple chains (via bridges or interoperability protocols) to maximize distribution.

- **Layer-2 Scaling Networks:** Thus far, we have not seen heavy RWA usage on optimistic or ZK-rollup L2s like Arbitrum, Optimism, or zkSync *yet*, but this is likely to change. L2s offer the security of Ethereum with far greater throughput. Projects are already testing on-chain Treasuries on Arbitrum, for instance. As L2 infrastructure matures (with decentralized sequencers, etc.), institutional comfort will grow. We anticipate that enterprise-friendly L2s (or permissioned rollups) will become venues for tokenization, combining compliance controls with Ethereum's settlement assurances.

Permissioned, Hybrid, and Consortium Blockchains: In parallel to public chains, a significant portion of RWA tokenization runs on permissioned DLT networks designed for regulated institutions:

- **Provenance Blockchain:** A prime example, Provenance is a permissioned chain (built on Cosmos SDK) tailored for financial assets. It powers Figure's loan marketplaces and has seen billions in loan tokens origination [marketsmedia.com]. Provenance uses a Proof-of-Stake model with known validators, giving institutions more control and privacy while still enabling on-chain efficiency. It is effectively a private ecosystem for lending, with connectivity to public chains achieved via bridges when needed (e.g., as in the JPM/Apollo Project Guardian trial using Axelar [businesswire.com].

- **Canton Network:** Launched in 2023, Canton is a consortium ledger (using Daml smart contracts) aimed at financial institutions for digital securities and bonds. It emphasizes privacy and interoperability among member platforms (which include major banks and market infrastructures). Notably, Canton-connected platforms have accounted for over half of all digital bond issuances since 2022 – about $4.6B out of $8B in digital bonds – demonstrating significant traction in the bond

market [canton.network]. Canton enables multiple applications (exchange, custody, payment systems) to synchronize on a privacy-preserving ledger, addressing the privacy concerns institutions have with public chains. Its rapid uptake for bond issuance suggests that hybrid models (privacy networks linked to public ones) will play a key role in tokenization.

- **Midnight Network:** Midnight is an upcoming data-protection blockchain focused on enabling confidential transactions and selective disclosure via zero-knowledge proofs. It is designed to let enterprises tokenize sensitive assets or data on a public yet privacy-preserving chain. For example, Midnight is collaborating with partners to deploy compliance-focused tokens (like Zoniqx's *DyCIST* standard) that allow *"built-in safeguards for seamless cross-border transactions"* [midnight.network]. While still in development, Midnight represents the trend of integrating privacy and regulatory compliance at the base layer, which could encourage institutions to utilize public networks without fearing data leakage.

- **Other Permissioned Chains:** There are several others in this category: JPMorgan's Quorum (an Ethereum variant) was used in early pilot networks (though JPM has pivoted to Onyx applications on both public and private systems); Hyperledger Fabric and Corda have been used in enterprise tokenization pilots (especially for trade finance assets and supply chain instruments, though with limited interoperability). Additionally, private Polygon networks and Ethereum enterprise chains (e.g., Canton itself interoperates with Ethereum via bridges for settlement assets) are emerging – these allow institutions to run their own blockchain ledgers with select counterparties while still connecting to the broader crypto liquidity when desired.

In practice, the landscape is evolving toward a "network of networks", where permissioned ledgers handle sensitive data and high-assurance transactions, then tie into public networks for broader market access. Projects like the Canton Network explicitly pursue this model. We anticipate continued co-existence of public and permissioned chains, with growing interoperability between them.

Smart Contract Standards for Tokenized Assets: On top of base blockchains, smart contract standards define the rules and capabilities of RWA tokens. Key standards include:

- **ERC-1400 (Security Token Standard):** ERC-1400 is a unified Ethereum standard (proposed in 2018) that combines several extensions to meet regulatory needs of securities [kaleido.io]. It provides a framework for partitioned ownership

(tranches of a token to represent different share classes or restrictions), document linking (attaching offering memos or disclosures to tokens), and transfer controls (e.g., an operator or admin can execute forced transfers or redemptions when required by law). By offering these features, ERC-1400 tokens can closely mirror traditional securities in terms of rights and compliance. Many early security token platforms (Polymath, Swarm, etc.) built on ERC-1400 or similar approaches, enabling things like forced transfers and whitelisting to prevent unlawful trades [polymath.network]. This standard laid the groundwork for treating tokens as regulated financial instruments with all necessary oversight.

- **ERC-3643 (Permissioned Tokens & Identity):** ERC-3643, formerly known as the T-REX protocol by Tokeny, is a newer standard explicitly designed for compliance-first tokens. An ERC-3643 token can *"only be held and transferred by verified participants,"* embedding identity verification and transfer restrictions directly into the token logic [chainalysis.com]. For example, a token might check an on-chain registry of approved investor addresses before allowing a transfer – if either party isn't verified or allowed (say, not an accredited investor or from a barred jurisdiction), the transfer fails. This standard also supports dynamic role-based permissions (so regulators or trustees could have certain administrative rights). ERC-3643 has been adopted by platforms like Tokeny and others in Europe to issue securities that automatically comply with EU prospectus rules, etc. The compliance-first design of ERC-3643 makes it ideal for real estate tokens, security tokens, and any regulated asset where you need ongoing control [chainalysis.com].

- **Other Notable Standards:** In the U.S., ERC-1404 (Simple Restricted Token Standard) offers a lightweight way to restrict transfers based on a set of rules (often used by Securitize and others in early implementations). ERC-721 (Non-Fungible Tokens) is used when unique assets are tokenized – e.g., an NFT representing a specific property or a single luxury asset. In those cases, platforms sometimes combine ERC-721 with wrappers to allow fractional ownership (splitting an NFT into fungible shares). We also see emerging standards for specific asset classes, such as ERC-1155 (multi-token standard) for tokenizing fund shares with multiple series, or newer Ethereum proposals that integrate soulbound identity tokens with financial tokens for compliance. Outside Ethereum, standards like FA2 on Tezos or CIP-30 on Cardano provide similar multi-asset token frameworks in their ecosystems.

Smart contract standards are crucial because they provide interoperability and investor protection. A common standard means wallets, exchanges, and custodians can uniformly support these tokens. As of 2025, ERC-1400 and ERC-3643 (and variants thereof) are

leading the way for security-like tokens, often used in combination (they are not mutually exclusive and can enrich each other [tokeny.com]. We expect ongoing evolution in this area – for instance, standards to enable on-chain corporate actions (voting, dividends) and integration with digital identity credentials are actively being refined.

Middleware and Tokenization Platforms: Sitting above the blockchain and smart contracts are the middleware services and platforms that actually allow institutions to tokenize assets easily. These include issuance platforms, custodial solutions, and API services that abstract away blockchain complexity. Some of the leading players include:

- **Firepan:** *(Detailed in Section 7)* Firepan provides a comprehensive software platform to tokenize, distribute, and manage real-world assets on-chain. It acts as infrastructure linking asset originators with the blockchain layer, while partnering with licensed custodians and compliance providers to handle the regulated aspects. Firepan's platform emphasizes an easy end-to-end process: asset issuers can convert physical assets into digital tokens "with third party compliance and asset verification" built in [firepan.com]. Firepan's stack includes modules for on-chain compliance (identity verification, whitelisting), secure smart contract deployment, and lifecycle management (distributions, redemptions, etc.). The platform is blockchain-agnostic, aiming to bridge assets to multiple

networks as needed. Firepan's value proposition is to be the #1 infrastructure for bringing real-world assets on-chain, enabling institutions to leverage blockchain without needing in-house crypto dev teams [firepan.com].

- **Securitize:** A pioneer in the security token space, Securitize offers an end-to-end tokenization platform that is both a technology provider and a regulated intermediary. It is a registered transfer agent and broker-dealer in the US, which allows it to issue tokenized securities and handle investor onboarding under compliance rules. Securitize's platform has been used to tokenize funds for BlackRock, KKR, Hamilton Lane, and Apollo among others [ledgerinsights.com]. For example, Securitize created a tokenized feeder fund for Apollo's credit fund, available to accredited investors with a $50k minimum, and distributed those tokens across six blockchains via Wormhole [ledgerinsights.com]. Securitize provides the digital transfer agent service (maintaining cap tables on-chain), a marketplace for secondary trading (Securitize Markets), and APIs for things like KYC/AML. Its ability to integrate compliance (investor accreditation, holding periods, etc.) into the token contract and its regulatory licenses give it a competitive edge in serving institutional tokenization needs. Essentially, Securitize acts as the bridge between traditional finance and blockchain, handling everything from smart contract issuance to investor management and custody through partners. This comprehensive approach was validated by BlackRock's choice to partner with Securitize on its first tokenized fund (the BUIDL fund)[ledgerinsights.com].

- **Centrifuge:** Centrifuge is a leading DeFi-centric RWA platform focusing on bringing real-world credit assets into decentralized finance. It operates its own blockchain (Centrifuge Chain, a Polkadot parachain) and the Tinlake application. Centrifuge allows asset originators (like invoice factoring firms, real estate bridge lenders, etc.) to tokenize their assets into NFTs, which are then pooled and financed by investors who receive two tranches of tokens (a senior "DROP" token and a junior "TIN" token). This creates on-chain asset-backed lending facilities. Centrifuge has facilitated funding of hundreds of millions of dollars in assets – its TVL hit $437M in May 2025 after launching new institutional products [nftgators.com]. A notable development is Centrifuge's partnership with asset managers to tokenize traditional funds (e.g., a Janus Henderson treasury fund) and make them accessible to DeFi liquidity. Centrifuge thus serves as middleware connecting traditional assets to DeFi liquidity pools. It also integrates with MakerDAO (Maker has onboarded some Centrifuge pools as collateral for DAI loans) and other DeFi protocols, positioning itself as a hub for on-chain credit. By

focusing on an open, decentralized model, Centrifuge complements the more permissioned platforms – together expanding the distribution channels for RWAs.

- **Other Platforms:** There are many other notable platforms in the tokenization ecosystem:
    - *Tokeny Solutions:* A European platform (out of Luxembourg) focusing on compliance tools (they pioneered ERC-3643) and tokenization of securities for mid-sized issuers, often in partnership with institutions like Euronext. Tokeny provides white-label tokenization software for everything from real estate to bonds, emphasizing identity-driven tokens and easy investor onboarding.
    - *Polymath:* Known for early work on ERC-1400 and its own blockchain (Polymesh), Polymath offers infrastructure for issuing and managing security tokens, targeting capital markets use cases with built-in compliance modules.

- *INX and tZERO:* These are SEC-registered trading platforms that also facilitate token issuance. INX, for example, has a platform for tokenized equities and bonds and operates an ATS (alternative trading system) for secondary trading. tZERO (pioneer in security tokens, formerly backed by Overstock) similarly provides a platform and ATS for tokenized assets (though its focus has shifted over time).

- *ADDX:* Based in Singapore, ADDX is a MAS-licensed exchange for tokenized securities and funds. It allows private market funds to be tokenized and fractions sold to accredited investors in Asia. ADDX often partners with major banks and asset managers to distribute their private offerings in tokenized form, providing an end-to-end service (issuance, custody, trading on its exchange). It notably collaborated with BCG on the $16T market study, highlighting its thought leadership [ledgerinsights.com].

- Numerous others like Tokenize Xchange (InvestaX) in Singapore, Oasis Pro in the US, Symbridge, Horizen Labs, STO Global-X, etc., each focusing on certain niches or regions.

Finally, custody and settlement providers form another critical part of the stack. Firms like Anchorage Digital, Hex Trust, Fireblocks, and Bank of New York Mellon are developing custody solutions specifically for tokenized securities, integrating features like multi-sig, MPC wallets, and seamless integration with traditional custody reporting. On the settlement side, projects like Fnality (Utility Settlement Coin) aim to provide on-chain cash for atomic DvP (delivery-vs-payment) when trading tokenized assets – a piece identified as important by institutions and even the BIS [bis.orgbis.org].

In summary, the technology infrastructure for RWA tokenization is robust and continually improving. Blockchains (both public and permissioned) form the foundation; smart contract standards ensure consistency and compliance; and an array of platforms and middleware tie it all together into usable solutions for institutions. The presence of large, regulated players in this stack – from major banks operating nodes on networks like Canton to asset managers investing in tokenization firms – underscores that this is a serious, professional market being built. The next section examines how regulators around the world are responding to and shaping these developments.

Regulatory Environment

Any discussion of tokenizing real-world assets must address the regulatory landscape. By turning securities, funds, or real estate into digital tokens, one must navigate securities laws, commodities regulations, property rights, and more. In 2024–2025, regulators globally have sharpened their focus on crypto assets, including RWAs, resulting in a patchwork of evolving frameworks. Here we provide jurisdictional highlights for the United States, European Union, Singapore, and the UAE – four key hubs – and review major regulatory developments over the past two years. We also discuss how compliance is being achieved in practice through technology and process.

The U.S. treats most tokenized real-world assets as securities (assuming they represent an investment contract, debt, or equity in an enterprise). Thus, tokenized RWAs generally fall under existing federal securities laws (1933 Act, 1934 Act, etc.) and oversight by the SEC. There is not yet a bespoke regulatory regime for security tokens; instead, the approach is *"same activity, same risk, same regulation."* For issuers, this means tokenized offerings must either be registered with the SEC or issued under an exemption (Reg D for accredited investors, Reg S for offshore, Reg A+ for small offerings, etc.). Over 2024, the SEC has provided some clarifications that affect tokenization:

- **Custody Rules:** In early 2024, the SEC proposed and later clarified expanded custody rules for investment advisers, explicitly including crypto and tokenized securities in the assets that require qualified custodians. This means institutional players holding tokenized assets on behalf of clients must use regulated custodians (banks, broker-dealers, or trust companies with crypto custody charters). The goal is to ensure the same protections for digital asset custody as for traditional securities. This clarification removed some uncertainty and has spurred traditional custodians (e.g. BNY Mellon, State Street) to advance their digital asset custody offerings.

- **Broker-Dealer and Exchange Guidance:** The SEC has been working through how existing definitions apply to platforms trading tokens. In 2024, the SEC's FinHub staff indicated that Alternative Trading Systems (ATS) can handle tokenized securities provided they comply with Reg ATS and national exchange laws. We saw FINRA approving the first broker-dealers for digital securities (e.g., Prometheum, Oasis Pro) signaling regulators are open to token trading venues under the right conditions. However, the SEC also warned that many crypto trading platforms might be unregistered exchanges if they list security tokens. This is pushing token markets to either register or operate under ATS frameworks

in the U.S.

- **Enforcement vs. No-Action:** The SEC has largely taken an enforcement-heavy stance in crypto, but interestingly, some tokenization projects have proceeded without issue. Cointelegraph noted *"the SEC concluded several investigations without enforcement actions... suggesting a move toward clearer frameworks that support innovation"* [cointelegraph.com]. For example, the SEC did not object to the Franklin Templeton on-chain money fund (which is a 1940 Act regulated fund) – in fact, the SEC had to explicitly approve certain aspects of that fund's blockchain recordkeeping, which it did. Such cases hint at regulatory openness if compliance is rigorously addressed.

- **Classification and Other Rules:** Beyond securities law, tokenized assets can trigger other U.S. regulations: e.g., a tokenized commodity (like gold or oil) might fall under CFTC oversight; tokenized real estate interests may invoke state real estate laws and SEC's Howey test (often they are also securities). The regulatory classification of stablecoins and tokenized bank deposits is also being grappled with (the OCC and Federal Reserve have weighed in on tokenized deposits and payment stablecoins, which, while not RWAs per se, form part of the ecosystem needed for RWA settlement). Broadly, U.S. regulators are cautious but are slowly adapting rules – a current bill in Congress is considering a regulatory regime for stablecoins and clarity on digital tokens, which could indirectly help RWA tokens by defining when a token is a security vs. not. Until comprehensive legislation arrives, the strategy for tokenization in the U.S. is to comply with existing regs (using registered broker-dealers, transfer agents, doing offerings under Reg D/S, etc.), and to engage proactively with agencies via sandboxes or no-action letter requests.

Compliance in the U.S. is handled through rigorous KYC/AML and accreditation checks at issuance (using platforms like Securitize or Oasis Pro that perform investor verification). Identity verification is mandatory – issuers must ensure only eligible investors (e.g. accredited in Reg D offerings) can buy tokens, which is achieved by whitelisting their wallet addresses after KYC. Periodic checks are required for transfers (often via smart contract or an off-chain approval process). Additionally, disclosures (offering memoranda, financial statements) must be provided just as in traditional offerings, often accessible via a token holder portal or embedded document hash on-chain. The bottom line: U.S. regulation is stringent, but the tokenization community is navigating it by mirroring traditional compliance on new rails.

The EU has moved proactively to create regulatory frameworks for digital assets, making it one of the more advanced jurisdictions. Two major regulatory pillars are relevant:

- **MiCA (Markets in Crypto-Assets Regulation):** Passed in 2023 and taking effect in 2024–2025, MiCA is the EU's comprehensive crypto assets law. MiCA primarily covers cryptocurrency, stablecoins, and utility tokens – it explicitly does *not* cover tokenized assets that qualify as financial instruments (those remain under existing securities laws). However, MiCA's existence still indirectly impacts RWA tokenization. For example, MiCA defines "asset-referenced tokens", a category that could include tokens referencing commodities or baskets of assets (like a tokenized gold or a token pegged to real estate value) [firepan.com]. Issuers of such tokens will need to be authorized and follow disclosure and reserve rules. Additionally, MiCA's requirements for crypto service providers (exchanges, custodians) will apply to any platform handling RWA tokens that are considered "crypto-assets" under MiCA. In practice, if the RWA token is basically a security (equity/debt), it will be regulated by MiFID II/MiFIR and related EU securities laws, not MiCA. The EU has also been working on a pilot regime specifically for DLT-based trading of securities:

- **EU DLT Pilot Regime:** In March 2023, the EU launched a 3-year pilot regime that allows market infrastructure (exchanges, settlement systems) to experiment with trading tokenized securities with selected regulatory waivers. This pilot lets venues handle tokenized equities, bonds, and funds in a sandbox-like environment (with limits like max €6bn market cap for equities, etc.) without needing full compliance with every traditional market rule. The goal is to identify adjustments needed in EU law to accommodate DLT. Already, multiple exchanges (e.g. Luxembourg Stock Exchange, Euronext, Deutsche Börse) have launched pilot platforms under this regime to trade digital bonds or tokenized funds. Early results are promising, and the pilot is fostering dialogue between industry and regulators on topics like how to do DvP settlement with tokens, how custody rules apply when a blockchain is the record of ownership, and how to handle investor protections (e.g. what happens if someone loses a private key that controls a security token). By 2026, the EU will likely integrate lessons from the pilot into permanent legislation for tokenized securities.

- **Other EU Developments:** The European Securities and Markets Authority (ESMA) and European Banking Authority (EBA) have been actively issuing guidelines on crypto and tokenization. In 2024, ESMA released guidance on the application of MiFID to security tokens, essentially confirming that a tokenized share or bond is still a share or bond by law. European regulators are also tackling stablecoins and tokenized money – for instance, the EU's recognition of e-money tokens and

requiring issuers to be authorized (which influences the settlement of RWA trades, since on-chain euros or other currency must come from regulated stablecoins or CBDCs in future). Notably, Switzerland (not EU but in Europe's sphere) has already amended its laws to recognize DLT-based securities formally, allowing digital ledger entries to be deemed securities with legal finality. This Swiss approach has enabled a number of digital bond issuances by companies like UBS, Credit Suisse on SDX (SIX Digital Exchange) with clear legal status. The EU may head in a similar direction.

Compliance in the EU for tokenized assets focuses on identity and transparency as well. Under MiCA and existing AML directives, any platform dealing with crypto assets must do full KYC on customers. The EU is rolling out a new Transfer of Funds rule for crypto (the "Travel Rule") which will require identifying info to accompany crypto transactions – tokenization platforms will need to build that in, especially for transfers between self-custody wallets. The concept of **"whitelisting" investors on a blockchain or using permissioned chains is quite accepted in Europe; for example, many tokenized bond pilots used a private Ethereum network where only KYC'd participants could join. In terms of disclosures, Prospectus Regulation would apply if a tokenized security is offered to the public in the EU above a certain size – meaning a prospectus might be required. However, many tokenization projects in Europe use either private placements or the prospectus exemptions (or seek the new EU "crypto-asset whitepaper" route under MiCA for those tokens that fall in MiCA's scope). Overall, the EU's stance is accommodating yet strict: they are creating explicit regimes to foster tokenization, but ensuring that investor protection and financial stability rules carry over to the new format.

Singapore is positioning itself as a global hub for asset tokenization through a supportive regulatory environment orchestrated by the Monetary Authority of Singapore (MAS). The MAS has launched numerous initiatives:

- **Project Guardian:** Announced in 2022, Project Guardian is MAS's collaborative sandbox program to explore DeFi applications in wholesale funding markets using tokenized assets. Under Guardian, MAS worked with banks like DBS, JPMorgan, and Marketnode to pilot tokenized bonds and forex transactions on public chains within a secure framework. By late 2024, Project Guardian demonstrated successful trades of tokenized Singapore Government Bonds against JPY currency tokens in a liquidity pool, and tokenized asset swaps, all under regulatory observation. The success of Guardian has led MAS to expand the program in 2024 to more participants and asset classes, essentially creating a "safe sandbox" for institutions to experiment with tokenization without immediate

regulatory consequences.

- **MAS Sandbox and Guidelines:** In November 2024, MAS announced plans to support the commercialization of asset tokenization by potentially adjusting regulations and creating new pilot programs [mas.gov.sg]. This included the idea of a Tokenization Sandbox for financial institutions – effectively allowing real transactions with certain regulatory flexibilities to test scaling tokenization. Singapore's regulators have also clarified rules around Digital Token Service Providers, indicating how platforms offering token trading or issuance to Singapore residents should be licensed [mas.gov.sg]. MAS is carefully delineating tokenized securities vs. payment tokens vs. other categories to apply the right rules to each.

- **Existing Framework:** Singapore already allows tokenized securities under its securities laws. Firms like InvestaX and ADDX hold Capital Markets Services licenses that let them issue and deal in digital securities. The legal status of a tokenized share or bond is recognized under Singapore law (similar to traditional book-entry securities). Singapore has also been progressive on recognizing digital forms of assets – e.g., the government is exploring tokenized versions of statutory securities (like tokenized forms of CPF bonds, etc.). Notably, Singapore's stock exchange (SGX) and government-backed companies created Marketnode, a digital asset platform for bond issuance that has done tokenized bond pilots since 2021.

- Recent highlights: Firepan's site notes *"Singapore MAS introduces RWA tokenization sandbox"* as a key regulatory update [firepan.com], consistent with MAS's public stance of encouraging controlled innovation. Additionally, Singapore's financial industry has launched projects such as DBS Bank's fixed income trading on blockchain, Temasek's Partior network (for payments), and digital asset funds authorized for distribution – all of which complement tokenization efforts.

In Singapore, compliance is centered on licensed intermediaries. Only MAS-licensed entities can facilitate trading of securities, so platforms like ADDX or InvestaX act as gatekeepers, performing full KYC/AML and ensuring only eligible investors (often restricted to accredited or institutional investors) access tokenized offerings. Identity is verified and linked to blockchain wallets (often the platform custodies the token on behalf of users, or uses a permissioned chain where user identities are known to the operator). Singapore has strict AML laws but is friendly to technological solutions – they likely would approve innovative approaches like on-chain credential checks as long as the outcomes

meet the regulatory requirement. Singapore's regulatory regime also requires proper disclosures and prospectuses for public offers, but it provides exemptions for private offers which many token deals use (e.g., limited to <50 investors or only to accredited investors to avoid prospectus).

One challenge MAS is working on is how to enable retail access safely – currently, most tokenized RWAs in Singapore are confined to accredited investors, but there is an intent in the future to broaden access once proper safeguards (perhaps AI-driven suitability checks or limited investment sizes) are in place. In summary, Singapore's environment can be described as "innovation under oversight" – MAS invites experimentation and has even directly participated in pilots, all while gradually updating regulations to support scaling those experiments into the mainstream financial system.

The UAE (particularly Abu Dhabi and Dubai) has emerged as a forward-thinking jurisdiction for digital assets, aiming to attract global businesses with a mix of innovation-friendly policies and clear regulations:

- **Multiple Regulatory Zones:** The UAE's regulatory landscape is unique with multiple zones – notably the Abu Dhabi Global Market (ADGM), Dubai International Financial Centre (DIFC), and Dubai's VARA (Virtual Asset Regulatory Authority) – each having their own rules that can apply to tokenization. ADGM was among the first globally to issue comprehensive digital asset regulations (back in 2018) and explicitly allowed security token offerings under its Financial Services Regulatory Authority (FSRA) framework. ADGM recognizes tokenized securities as a class of "digital securities" and has licensed exchanges and custodians to handle them. DIFC's regulator (DFSA) in 2023 launched tokenization guidelines as well, including a framework called the Innovation Testing Licence that lets firms test tokenized securities with DFSA supervision.

- **Dedicated Tokenization Initiatives:** Dubai's DIFC has created a special regulatory environment to test tokenized securities (including real estate shares, sukuk (Islamic bonds), and fund units) under full regulatory oversight [tokeny.com]. This sandbox enables firms to trial new tokenization business models with real assets in a controlled setting. At the same time, Dubai Land Department (the real estate registry) working with VARA has begun integrating property title registries with blockchain [tokeny.com]. This means legally recognizing and recording property ownership via digital tokens on a blockchain – a huge step for real estate tokenization, as it ties the token directly to the government land registry. If fully realized, this would allow on-chain transfer of property ownership with automatic update of the official registry, vastly simplifying real estate transactions.

- **Launch of Regulated Tokenization Programs:** The UAE's approach is somewhat federated: ADGM might approve a tokenized fund; DIFC might run a pilot for tokenized bonds. One headline example is the FAB (First Abu Dhabi Bank) / IHC / ADQ stablecoin (AE token)** – a UAE Dirham-backed stablecoin launched by major institutions [tokeny.com]. While a stablecoin, its significance for RWAs is that it provides an on-chain payment rail in local currency, facilitating tokenized asset trades and settlements domestically. Additionally, Mubadala's Hub71 in Abu Dhabi is attracting tokenization startups, and multiple real estate tokenization platforms have set up in UAE to sell fractional property investments (some regulated by VARA for marketing to investors).

- **Legal Recognition:** The UAE is moving toward formal legal recognition of digital records. In mid-2024, the federal government discussed updating laws to recognize cryptographic tokens as proof of ownership for assets, which would bolster confidence in tokenized rights. For now, in practice, many tokenized assets in the UAE still involve traditional legal structures underpinning them (e.g., a Special Purpose Vehicle holds a property and issues tokens representing shares in the SPV), but the direction is toward more direct token = asset equivalence under law.

Compliance in the UAE is facilitated by the fact that participation is often through regulated firms. For example, an exchange in ADGM listing tokenized securities must perform full KYC/AML on its customers per FATF standards (the UAE has implemented strict AML laws and is improving enforcement). The UAE's free zones allow flexibility in authorizations – e.g., a crypto firm can get an ADGM license for operating a Multilateral Trading Facility (MTF) for digital securities. Investors (often global, attracted by the UAE's tax regime and innovation) can trade on these platforms under the UAE rules, which include surveillance for market abuse, disclosure of token issuer information, etc. The UAE is also uniquely open to retail involvement in certain token projects, within limits – for instance, fractional property tokens have been sold to retail investors in Dubai, with VARA ensuring advertising and custody rules are in place to protect buyers.

Overall, the regulatory environment is gradually normalizing the treatment of tokenized assets, incorporating them into existing legal frameworks while developing new guidelines where needed. Regulators in major jurisdictions are increasingly conversant in blockchain concepts, and many have set up innovation offices or sandboxes to work with industry (e.g., the UK FCA and Japan's FSA also have done notable work on tokenization, though not detailed above). By 2025, we see legal fragmentation still – different rules in different places – but also some convergence on core principles: KYC/AML is non-negotiable, token issuers must be accountable, technology can be used to enhance compliance, and investor protections must remain equivalent to traditional finance. For tokenization to reach full potential, further regulatory clarity and perhaps harmonization will be needed. Encouragingly, bodies like the Financial Stability Board (FSB) and IOSCO have tokenization working groups, and even the Bank for International Settlements (BIS) has advocated for a future "unified ledger" combining tokenized assets and central bank money for optimal oversight [bis.org]. In practice, compliance technology is filling some gaps – for example, travel rule compliance networks for crypto transactions, or analytics to monitor token flows for suspicious activity – giving regulators more confidence as the market scales.

The next section will examine how institutions have been *adopting* tokenization within this regulatory context – highlighting real case studies of how major players navigate compliance and leverage technology to tokenize assets successfully.

Institutional Adoption & Case Studies

One of the clearest signals that tokenization has arrived is the robust participation from leading financial institutions. In 2025, we see not only startups, but some of the world's largest asset managers, banks, and corporations initiate tokenization projects. Below we profile several high-profile institutional use cases that illustrate *what* is being tokenized, *how* these initiatives were executed, and *what outcomes or benefits* were achieved. These case studies underscore that tokenization is delivering real value – whether by unlocking new liquidity, improving operational efficiency, or broadening investor access – for those at the forefront.

- **BlackRock – Tokenized Money Market Fund (BUIDL):** In March 2024, BlackRock – the world's largest asset manager – launched its first tokenized fund, marking a watershed moment. The BlackRock USD Short-Term Investment Fund (symbol BUIDL) was issued as digital tokens on a blockchain (Ethereum and additional networks via interoperability) in partnership with Securitize [cointelegraph.com]. BUIDL is essentially a tokenized money market fund investing in ultra-short U.S. Treasuries and similar assets, targeting institutional liquidity management needs. The results were striking: within 3 weeks of launch, the fund's assets under management tripled from $615 million to $1.87 billion [cointelegraph.com]. This explosive growth (described by observers as *"the tokenization wave…hitting faster than most realize"* [cointelegraph.com] made BUIDL one of the largest on-chain RWA products almost overnight. The fund's tokens were initially offered to qualified investors, providing them 24/7 on-chain liquidity for what is traditionally a staid product. BlackRock achieved faster settlement (instant transfer of fund shares vs. T+1) and the ability for investors to pledge these tokens as collateral in real-time (see the BlackRock-Barclays-JPM case below). Larry Fink noted that tokenization and instantaneous settlement could *"dramatically reduce operational friction"* in markets [ledgerinsights.com]. Indeed, BlackRock's move validated tokenization's promise: it *proved* that even conservative, large-scale funds can be tokenized in a compliant way. The BUIDL fund success also signaled to the market that BlackRock envisions a tokenized future – a vision echoed by Fink's public statements. It's worth noting that BlackRock's tokenized fund isn't about giving retail crypto users a new product; rather it was aimed at institutional

liquidity, showing the efficiency gains for big players. By year-end, BUIDL tokens were being used in pilot transactions to meet margin calls instantly, and BlackRock began exploring tokenizing other funds (potentially a share of its $10T AUM) – hence the moniker "$10 Trillion Tokenization Vision" circulating in the press.

- **JPMorgan Onyx – Tokenized Collateral & Repo (TCN and Intraday Repo):** JPMorgan has been a trailblazer in blockchain among banks, and its Onyx division has delivered some of the most tangible real-world asset tokenization results. The Onyx Digital Assets platform focuses on institutional capital markets use cases. Since launching a few years ago, JPM's Onyx has processed over $300 billion in tokenized short-term loans (repo transactions) using tokenized U.S. Treasury bonds as collateral [tokenist.com]. This intraday repo application effectively allows JPMorgan and partner banks to exchange tokenized Treasury tokens against cash within minutes, rather than the traditional day(s) it takes to mobilize collateral. By mid-2023, J.P. Morgan reported its blockchain repo network had facilitated over $300B in trades, underscoring how a private blockchain can handle high-volume institutional usage [ledgerinsights.com]. In 2023, Onyx expanded this capability by launching the Tokenized Collateral Network (TCN), and bringing in partners like BlackRock and Barclays [ledgerinsights.com]. In a notable first transaction, BlackRock tokenized shares of one of its money market funds (possibly the BUIDL fund mentioned prior) and pledged them as collateral to Barclays for a derivatives margin requirement [ledgerinsights.com]. The entire process settled on Onyx's blockchain instantly. This demonstrates a powerful benefit of tokenization: assets that normally sit idle (e.g. fund shares) can be made more liquid and used in real-time financing. BlackRock commented that tokenized collateral could *"dramatically reduce friction in meeting margin calls"* [ledgerinsights.com]. JPMorgan's Onyx also includes JPM Coin, a tokenized deposit used for value transfer, and has done projects in trade finance. The key measurable outcomes from JPM's tokenization endeavors include reduced settlement times (intraday vs overnight), improved liquidity usage, and greater market liquidity during high-rate environments (when intraday liquidity is precious). Furthermore, JPMorgan has shown that large-scale tokenization can happen *within existing regulatory frameworks* – their repo network runs under existing master agreements, just using blockchain for settlement. Onyx's success has spurred other banks (BNP Paribas, Goldman Sachs, etc.) to join or build similar networks [ledgerinsights.com]. It's a prime example of an incumbent bank using tokenization to optimize a core business function (collateral management) at massive scale.

- **Franklin Templeton – On-Chain U.S. Government Money Fund (BENJI tokens):** Franklin Templeton became a pioneer by launching the first U.S.-registered mutual fund on a public blockchain. The Franklin OnChain U.S. Government Money Fund (FOBXX) is a government money market fund whose official share ownership record is maintained on-chain (originally Stellar, now also Polygon) [cryptoslate.com]. The fund, which invests in U.S. Treasuries and government debt reached approximately $300–$400 million in assets that are represented as digital tokens (called BENJI tokens) [cryptoslate.com]. Franklin Templeton achieved this under the oversight of the SEC by working with regulators to ensure compliance – each BENJI token equals one fund share, and the transfer agent uses the blockchain as its ledger of record (with appropriate controls on wallet creation for investors) [franklintempleton.com]. This case is significant for a few reasons. First, it proved out operational efficiency: share transactions and redemptions that used to take a day can be done same-day because the blockchain processes them in real-time. Second, it enhances accessibility: while still limited to certain investor categories, the technology would allow 24/7 transfer of fund shares (for instance, two investors can swap fund tokens peer-to-peer without involving the fund manager, subject to compliance). Franklin has integrated this with wallet providers so that investors can hold fund tokens alongside other digital assets. The fund's measurable outcome has been successful daily operations with on-chain settlement, demonstrating that regulated funds *can* run on blockchain without issue. Franklin has publicly touted improved shareholder transparency (since the cap table is always up-to-date on-chain) and expects cost savings in the long run by eliminating intermediate reconciliation processes. This case also broke ground for other asset managers: seeing the SEC allow a 1940-Act fund to be tokenized gave confidence to others (like BlackRock and Fidelity) to explore similar ideas. Franklin's BENJI tokens also served as a model for on-chain cash management – interestingly, MakerDAO (a DeFi protocol) even invested some DAI stablecoin reserves into Franklin's fund via a special tokenized share class, linking DeFi to TradFi. In summary, Franklin Templeton's case shows a traditional fund sponsor leveraging blockchain to modernize an existing product, gaining operational efficiency and offering tech-savvy investors a new way to access a very traditional asset (government money fund) on digital rails.

- **Hamilton Lane – Tokenized Private Equity Funds via Securitize:** Hamilton Lane, a prominent global private markets investment firm, has been at the forefront of using tokenization to broaden access to its funds. In 2023, Hamilton Lane partnered with Securitize to tokenize portions of several flagship funds, including its $5.6 billion Secondary Fund (Fund VI) and its Equity Opportunities Fund V, and

later a Senior Credit Opportunities (SCOPE) Fund [prnewswire.com]. The tokenized feeder funds were offered on Securitize's platform to accredited investors at much lower minimums (e.g. $20,000–$100,000) than the millions usually required to invest in such funds [linkedin.com]. The tokenization process involved creating a feeder vehicle that invests in the main fund, and issuing digital tokens representing interests in that feeder. Outcomes and benefits:

- *Broader Investor Base:* Hamilton Lane was able to welcome a new class of high-net-worth and smaller institutional investors who previously could not meet the high minimums. By lowering the minimum from ~$5 million to $100k or even lower in some cases [linkedin.com], the firm tapped into pools of capital that were unreachable before. In the first tokenized fund offering, the allocation sold out quickly, indicating strong demand.

- *Operational Efficiency:* Using Securitize's digital onboarding, the subscription process for these private funds was streamlined. Investors could sign up, complete KYC/AML and accreditation checks online, and receive tokens in a matter of days – compared to lengthy paperwork traditionally. Cap table management was also simplified; distributions (when the fund paid out) were automated to token holders via smart contracts linking to stablecoin payouts or bank accounts.

- *Liquidity Potential:* While private equity funds are long-term and illiquid by nature, Hamilton Lane's tokenization initiative set the stage for potential secondary liquidity. Securitize Markets allows token holders to post their tokens for sale to other qualified investors under Rule 144 or other exemptions. Within months of issuance, there was some secondary trading of the tokenized fund interests, a novelty in the private equity world where secondaries usually involve brokers and heavy discounts. This hinted at how tokenization can create continuous price discovery for private assets, or at least easier transfers.

- *Strategic Advantage:* Hamilton Lane positioned itself as an innovator among its peers (KKR, Apollo, etc.), which likely contributed to positive branding and relationships (indeed, in 2024, Hamilton Lane also invested in Securitize's funding round [hamiltonlane.com], deepening that partnership). The firm publicly stated that tokenization could "democratize access" to private markets – aligning with broader industry trends of "retailization" of alts.

In summary, Hamilton Lane's foray demonstrated that even complex multi-billion dollar alternative investment vehicles can be represented as tokens, yielding benefits in distribution and investor reach without compromising on regulatory compliance or fund management.

- **KKR – Tokenized Portion of Private Equity Fund on Avalanche:** In one of the earliest major examples (September 2022), global investment firm KKR tokenized an interest in its Health Care Strategic Growth Fund II via the Securitize platform [coindesk.com]. While not a 2024 event, it laid important groundwork. KKR's tokenized feeder fund was offered to investors on the Avalanche blockchain, with Securitize as the issuer. The tokenization allowed KKR to cut the minimum investment from $5 million to $100,000, thereby including high-net-worth investors who normally couldn't access KKR's funds [linkedin.com]. The outcome was a successful subscription of the available tokenized portion, proving out the model. KKR reported that the tokenized feeder helped *"expand our investor base in a scalable way"*. It also validated Avalanche as an infrastructure for security tokens, being able to enforce compliance and handle transactions efficiently. This case was closely watched by the industry; its success arguably influenced peers (like Hamilton Lane above, and Apollo) to pursue similar tokenized offerings. While relatively small in scale (a portion of a fund), the KKR case is a milestone demonstrating a top-3 private equity firm embracing blockchain to innovate in product distribution. It also was a test of legal structuring – careful work was done to ensure the tokenized feeder complied with SEC Reg D and that token transfers would respect securities law (similar to Hamilton Lane's approach). Post-launch, the tokens have had limited liquidity (consistent with private market nature), but KKR and Securitize proved that tokenization can handle the heavy compliance lift of private funds. Notably, this fund's performance or payouts can now theoretically be automated to token holders via smart contracts. KKR's willingness to tokenize a flagship fund increased credibility for RWA tokens across Wall Street.

- **Apollo Global Management – Tokenized Credit Fund and Portfolio Integration:** Apollo, a $500+ billion alternative asset manager, has been active on multiple fronts. Aside from participating in JPM's Project Guardian POC, Apollo in 2024 launched a tokenized feeder for its Apollo Diversified Credit Fund (ACRED) via Securitize [ledgerinsights.com]. Uniquely, Apollo's tokenized fund is available across several blockchains (Ethereum, Polygon, Solana, etc.) using Wormhole interoperability – a first-of-its-kind approach to reach investors wherever they are. Early investors in the Apollo tokenized fund even included crypto-native institutions like Coinbase and Kraken, indicating a bridge between TradFi and

crypto investors [ledgerinsights.com]. Apollo's goals were to tap global accredited investors and provide a new channel for raising capital for its credit strategies. The launch has been successful in attracting attention and initial capital (exact figures undisclosed, but it's one of the larger tokenized offerings to date). Apart from fund tokenization, Apollo (through its subsidiary Figure and joint efforts with Onyx) has been exploring personalized portfolios via tokenized funds [ledgerinsights.com]. They published research with JPMorgan on how semi-liquid alternatives (like interval funds, private credit) can be more readily included in wealth management portfolios if tokenized [provenance.io]. The measurable outcome they highlight is that a multi-asset portfolio with tokenized alts can be managed with *"automated rebalancing across blockchains"* (as shown in Project Guardian) [businesswire.com]. In essence, Apollo is not only tokenizing products but rethinking how to manage and distribute them using blockchain. The result could be mass-customized portfolios where an investor's allocation to Apollo's strategies is delivered via tokens that the investor can adjust in real-time – something not possible with illiquid alts today. Apollo's engagement underscores that top private asset managers see tokenization as strategic, promising operational efficiencies and new markets.

- **Onyx & BlackRock/Barclays – Tokenized Collateral Pilot:** *(This is a hybrid case but worth noting).* In late 2023, BlackRock and Barclays joined JPMorgan's Onyx Tokenized Collateral Network to test real-world use of tokenized assets in collateral management [ledgerinsights.com]. BlackRock tokenized shares of a money market fund (value in the millions) and transferred them to Barclays, who accepted them as collateral for a derivatives transaction [ledgerinsights.com]. The pilot's measurable result was that the transfer and pledge were settled instantaneously, vs. a traditional process that could take a day or more to arrange and settle via custodians. The context is rising interest rates making intraday funding more valuable – instant collateral posts can reduce the need to hold excess buffers. This case is included to show inter-institutional adoption: multiple big players coordinating via a blockchain network. It highlights that tokenization isn't just for standalone projects, but for improving interactions between institutions (in this case, streamlining margin calls and collateral flows). Following this, other banks like BNP Paribas indicated plans to join similar networks [ledgerinsights.com]. We see the beginning of a network effect: as more institutions tokenize eligible collateral, the efficiency and liquidity of the overall market improves, encouraging further adoption.

Other noteworthy institutional moves (briefly): Goldman Sachs issued a digital bond on a private blockchain and has been developing its GS DAP platform for asset tokenization.

European Investment Bank (EIB) issued multiple digital bonds on public Ethereum (in 2021 and 2022, €100M and €50M respectively), with participation from major banks – a public sector push showing confidence in tokenized issuance. HSBC and Wells Fargo have used a blockchain for bilateral FX settlement with tokenized cash. UBS through SDX issued tokenized fixed income products and is exploring tokenized variable capital company (VCC) funds in Singapore. And Fidelity has not only invested in tokenization startups but also launched a crypto asset management platform that envisions handling tokenized securities down the line.

In summary, institutional adoption spans use cases from funds, bonds, loans, collateral, to settlement cash. The common theme is these projects are no longer in just a proof-of-concept stage, but rather they are either live or in advanced pilot, with real money and real assets at stake, and often delivering improvements in speed, cost, or access. Importantly, these institutions report that tokenization *does not break the law* or create chaos; rather, when done in partnership with regulators, it can *enhance* transparency and control (for example, every movement of BlackRock's tokenized fund shares is traceable on-chain, arguably more transparent than traditional omnibus accounts). Each success story builds confidence and paves the way for broader adoption, both by the institution itself (scaling up the initiative or tokenizing more assets) and by industry peers who learn from the example.

The next section will turn to the remaining hurdles that need to be addressed for tokenization to truly go mainstream. Despite the success of these case studies, challenges exist in legal frameworks, market liquidity, and operational know-how, which we will discuss along with efforts to overcome them.

INSTITUTIONAL ADOPTION

Leading financial institutions are actively tokenizing assets, delivering real value (2024-2025):

BlackRock

Tokenized Money Market Fund (BUIDL)

Tech: Ethereum, Securitize

- 🚀 ~$1.87B AUM in 3 weeks (Mar 2024).
- 💨 Instant settlement & 24/7 on-chain liquidity.
- 🔗 Enabled tokenized collateral (e.g., with Barclays/JPM).

Larry Fink: Tokenization could 'dramatically reduce operational friction'.

JPMorgan Onyx

Tokenized Collateral Network (TCN) & Intraday Repo

Tech: Onyx Digital Assets (Private Blockchain)

- 💸 Over $300B in tokenized short-term repo loans processed.
- ⚡ Instant collateral settlement (minutes vs. days).
- 🤝 Partnerships with BlackRock, Barclays for TCN.

Improving liquidity usage and settlement times at institutional scale.

Franklin Templeton

On-Chain U.S. Gov. Money Fund (BENJI tokens)

Tech: Stellar, Polygon

- 💰 ~$300-400M AUM, SEC-compliant.
- ⚙️ Same-day share transactions & redemptions.
- 📊 Enhanced shareholder transparency via blockchain ledger.

Pioneered first U.S. registered mutual fund on a public blockchain.

Hamilton Lane

Tokenized Private Equity Funds

Tech: Securitize

- 👥 Broader investor access (min. $20k vs. millions).
- 📈 Streamlined digital onboarding & cap table mgmt.
- 🔄 Potential for secondary liquidity on Securitize Markets.

'Democratizing access' to private markets for HNW & smaller institutions.

KKR

Tokenized Portion of Health Care Fund

Tech: Avalanche, Securitize

- 🎯 Expanded investor base ($100k min vs $5M).
- ✅ Validated Avalanche for security tokens & compliance.
- 💡 Influenced peers to explore similar offerings (2022).

Early major PE firm embracing blockchain for product distribution.

Apollo Global Management

Tokenized Credit Fund (ACRED) & Portfolio Integration

Tech: Securitize, Wormhole (Multi-chain: ETH, Polygon, Solana)

- 🌐 Multi-blockchain fund access for global accredited investors.
- 🧩 Exploring automated rebalancing of tokenized alts in portfolios.
- 🏦 Attracted crypto-native institutions (Coinbase, Kraken).

Rethinking portfolio management with tokenized semi-liquid alternatives.

Other Notable Moves

- **Goldman Sachs:** GS DAP platform, digital bonds.
- **European Investment Bank (EIB):** Multiple digital bonds on public Ethereum.
- **HSBC & Wells Fargo:** Bilateral FX settlement with tokenized cash.
- **UBS (SDX):** Tokenized fixed income, exploring tokenized VCC funds.
- **Fidelity:** Crypto asset management, investing in tokenization.

These cases show live projects with real assets, improving speed, cost, or access.

Challenges & Bottlenecks

While the progress in RWA tokenization is impressive, significant challenges and bottlenecks remain. These issues span legal, regulatory, technological, and market domains. Overcoming them will be critical to unlock the full potential of tokenization. Below, we outline the key challenges and how the industry is addressing or may address them:

- **Legal Fragmentation & Uncertainty:** A fundamental challenge is that the legal status of tokenized assets can be unclear or inconsistent across jurisdictions. Today, there is *"no legally recognized commonality between ownership of a digital token and the underlying asset"* in many places [law-kc.com]. For example, if you hold a token that represents a share in a property, does that token *legally* equate to an ownership interest enforceable in court? In some jurisdictions like Switzerland or Delaware (USA), laws have been updated to clarify this (recognizing certain tokens as securities or property records). But elsewhere, token holders might only have contractual claims via the issuer. Additionally, each country has its own approach to crypto and securities – an offering might be legal in Singapore but not allowed in the US for retail. This fragmentation raises costs and complexity: issuers must structure tokens to comply with multiple regimes or geofence certain investors. It can also impede *secondary trading* – a willing buyer and seller across borders might find that transferring a token could violate one country's rules. To mitigate this, industry groups and bodies like the Global Digital Finance consortium are advocating for more harmonized standards. Some countries are signing Mutual Recognition agreements for digital securities (e.g., Switzerland and Germany exploring acceptance of each other's digital bond frameworks). Until more uniformity arrives, many issuers take a *"jurisdiction-by-jurisdiction"* approach, launching tokens in friendly regimes first and limiting access elsewhere. Overcoming legal uncertainty will likely require new legislation or clear case law establishing tokenized assets as valid representations of ownership globally – a process that could take years. In the meantime, careful legal structuring (like robust token terms & conditions, fallback mechanisms to traditional systems) is used to give investors confidence.

- **Regulatory Complexity and Compliance Costs:** Tokenization often faces the *full stack* of financial regulations – securities laws, investment company rules, banking and payments regs (for stablecoins), tax rules, etc. Complying with all of these in a novel context can be costly. For instance, to do a tokenized securities offering in the US, one might need to involve a broker-dealer, a transfer agent, possibly get an alternative trading system license for liquidity – this is burdensome for smaller

issuers. Regulatory uncertainty also persists in definitions: some tokens might be classified differently by different agencies (e.g., is a tokenized gold bar a "commodity" or a "security" or just a warehouse receipt?). Companies sometimes must seek individual regulatory approvals or sandbox participation which slows time-to-market. Moreover, the lack of regulatory clarity in the US around what is or isn't a security token has made some firms hesitant (fear of enforcement). The industry is addressing this by engaging regulators (public comment letters, participating in sandboxes) and by building compliance automation tools to ease the burden. For example, identity-token standards (ERC-3643 etc.) directly encode KYC rules into tokens, which helps satisfy regulators that only eligible investors can hold them [chainalysis.com]. Compliance processes are being streamlined via technology – e.g., using NFTs to represent investor identity verification that any security token smart contract can check before allowing a trade. Nonetheless, until regulators finalize clear rules (such as new categories or exemptions for tokenized offerings), compliance will remain a heavy (though necessary) lift.

- **KYC/AML and Identity Verification Hurdles:** As echoed throughout, a major challenge is integrating strict Know-Your-Customer (KYC) and Anti-Money Laundering (AML) controls into a technology (blockchain) that is pseudonymous by default. Traditional finance requires verified identities for investors, reporting of suspicious activities, sanctions screening, etc. Public blockchains do not inherently have these features. Currently, the workaround is *off-chain KYC*: platforms verify users and then whitelist their blockchain addresses. This is effective but not scalable if a user wants to use many different services – they'd have to KYC multiple times. It also can be brittle; if a token is transferred to an address not on the whitelist, the smart contract might block it, or if someone completes KYC and then their address changes, there are manual updates. Additionally, AML compliance (monitoring transactions for illicit behavior) can be challenging when tokens can move to self-custodied wallets – though analytics firms (Chainalysis, Elliptic, etc.) are increasingly able to trace even complex token flows, giving comfort that risk can be managed. The industry is working on on-chain identity solutions such as verifiable credentials and soulbound tokens that could convey KYC status without revealing private data publicly. For example, an issuer might accept a Zero-Knowledge proof that "Wallet X belongs to a US accredited investor" without needing to know the person's name. This preserves privacy while fulfilling regulations. Coinbase predicts that *"wallet verification processes will improve meaningfully in 2025 as on-chain attestations gain traction"* [marketsmedia.com]. Projects like Polygon ID or Civic are building infrastructure for this. Another aspect is AML whitelists/blacklists – known bad

actor addresses can be blacklisted in token smart contracts, and conversely, only approved exchanges or wallets can be interacted with (to avoid exposure to mixers or sanctioned parties). These technical approaches, combined with regulatory tech (regtech) off-chain, aim to turn what is a challenge into a strength: fully traceable asset histories on blockchain can actually exceed traditional banks in transparency (the BIS noted that tokenization could improve AML effectiveness if done right [dailyhodl.com]. However, getting multiple jurisdictions to accept on-chain identity standards is a work in progress.

- **Investor Accreditation and Access Limits:** One often-cited goal of tokenization is to "democratize" access to assets like private equity, real estate, etc. – but in practice, most tokenized RWA offerings today are limited to accredited or institutional investors. This is due to securities regulations that protect retail investors via registration requirements. Registering a public offering of a tokenized asset is possible (e.g., a REIT could tokenize and list on an exchange), but many issuers choose exemptions (Reg D, etc.) to avoid the time and expense of registration, which by default limits the investor base. Thus, the benefits of tokenization (like fractional ownership) aren't yet reaching unaccredited retail in a big way, at least not in highly regulated markets. This is a challenge both in fairness and in achieving full liquidity (the pool of accredited investors is smaller). Overcoming this likely requires regulatory evolution – for instance, regulators could create limited retail tiers for tokenized products, where retail can invest small amounts under a crowdfunding-like framework or where certain "low-risk" tokenized assets (like tokenized government bonds) could be offered widely. Europe's MiCA, for example, allows offering certain asset-referenced tokens to retail with a light whitepaper, as long as they aren't shares or bonds (which then fall under prospectus rules). Another angle is using structured products: e.g., wrapping a tokenized asset in an ETF-like structure that *is* tradable by retail (we see early signs with ETFs investing in tokenized instruments, or ETPs in Europe that give exposure to tokenized bonds). Until such mechanisms mature, tokenization's promise of inclusion will remain partly unrealized. Education also plays a role – even when allowed, will retail trust and understand tokens? The industry (including companies like Firepan) is trying to educate both investors and regulators on the safety and benefits of broader access, which in time could soften the stance on accredited-only limitations.

- **Secondary Market Liquidity (or Lack Thereof):** Illiquidity is a major bottleneck for tokenized RWAs once issued. Many token holders find few buyers or trading venues if they want to sell. Unlike cryptocurrencies, which trade on many exchanges, security tokens have fragmented liquidity on small ATS platforms or

peer-to-peer. For example, the trading volume of all security tokens globally is still very low (tens of millions per month at most). Without liquidity, one of the touted benefits of tokenization (easy exit/entry) falls short, and investors may be hesitant to buy in the first place. Several factors cause this: regulatory constraints (only certain participants can trade, reducing market size), the novelty (few market makers or institutional traders specialize in these yet), and the "chicken-and-egg" problem (liquidity begets liquidity, but early markets have none). However, we are seeing improvements:

- Dedicated marketplaces like tZERO, Oasis Pro, Securitize Markets, ADDX are steadily growing their user base and listings. As more assets list, they can attract more investors in a virtuous cycle.

- Some tokenized funds have implemented periodic liquidity windows or bulletin board trading to provide at least intermittent liquidity.

- On the DeFi side, protocols like Uniswap or new specialized AMMs are being experimented with for security tokens (with the caveat that only whitelisted wallets can interact, turning the pool effectively into a permissioned pool). This could bring automated liquidity provision to tokens.

- Market makers are slowly entering: firms that traditionally make markets in bonds or ETFs are exploring making markets in tokenized Treasuries or tokenized corporate bonds. As an example, SBI Digital Asset Holdings in Japan has market-made some digital bonds on their platform.

- Regulatory developments may allow interlisting of tokens on traditional exchanges. The Nasdaq and London Stock Exchange have shown interest in supporting digital assets trading alongside traditional securities once legally feasible. If tokenized securities could tap into traditional exchange liquidity (even via depositary receipts or ETFs), it would be a game changer.
  Ultimately, improving liquidity may simply take time and volume – as more high-quality assets (like sovereign bonds, blue-chip equity, flagship funds) are tokenized, they will attract more buyers, which in turn invites more sellers, etc. Patience is required; markets need to reach critical mass. In the interim, many token issuers manage expectations by designing tokens for medium-term holding more than day-trading.

- **Custody and Key Management:** Holding tokenized assets introduces the complexity of managing cryptographic keys – a far cry from the traditional experience of holding securities via a broker or custodian bank. Institutional investors often *cannot* hold their own keys due to internal policies or regulatory mandates; they require a qualified custodian. As such, the nascent state of digital asset custody infrastructure is a bottleneck. Many custodians are still building secure systems for multi-sig or MPC (multi-party computation) custody that meet standards (SOC2, etc.). Additionally, questions arise like: how do you handle custody for a token that's on a public chain (with risk of loss/theft) vs. a token on a permissioned chain (maybe simpler, as specific network access controls exist)? Another custody issue is segregation and insurance – ensuring that if a custodian goes bankrupt, tokenized assets are bankruptcy-remote (the law is clear on securities in most countries, but is it clear on tokens? Some jurisdictions like Germany have clarified crypto assets should be treated similarly to client assets). There's also the human factor: wallet addresses are unforgiving (send an asset to the wrong address, it's gone), smart contracts could have bugs – these technical risks make traditional institutions cautious. Indeed, technological risk is cited: *"smart contract exploits or private key leaks"* are a concern Coinbase highlighted for public chain tokenization [marketsmedia.com]. Solutions:

    - Professional custodians like Anchorage, Coinbase Custody, BitGo, Fireblocks offer services to safely store tokens with enterprise-grade security (HSMs, policy controls, etc.). Many have either obtained bank charters or trust charters to be qualified in US terms.

    - Insurance providers are slowly expanding coverage to digital asset losses, which will help investors feel secure that if a custodian mishandles keys, there's recourse.

    - Some projects use multi-signature escrow arrangements where multiple parties (issuer, trustee, custodian) control different keys – preventing unilateral moves and adding layers of safety.

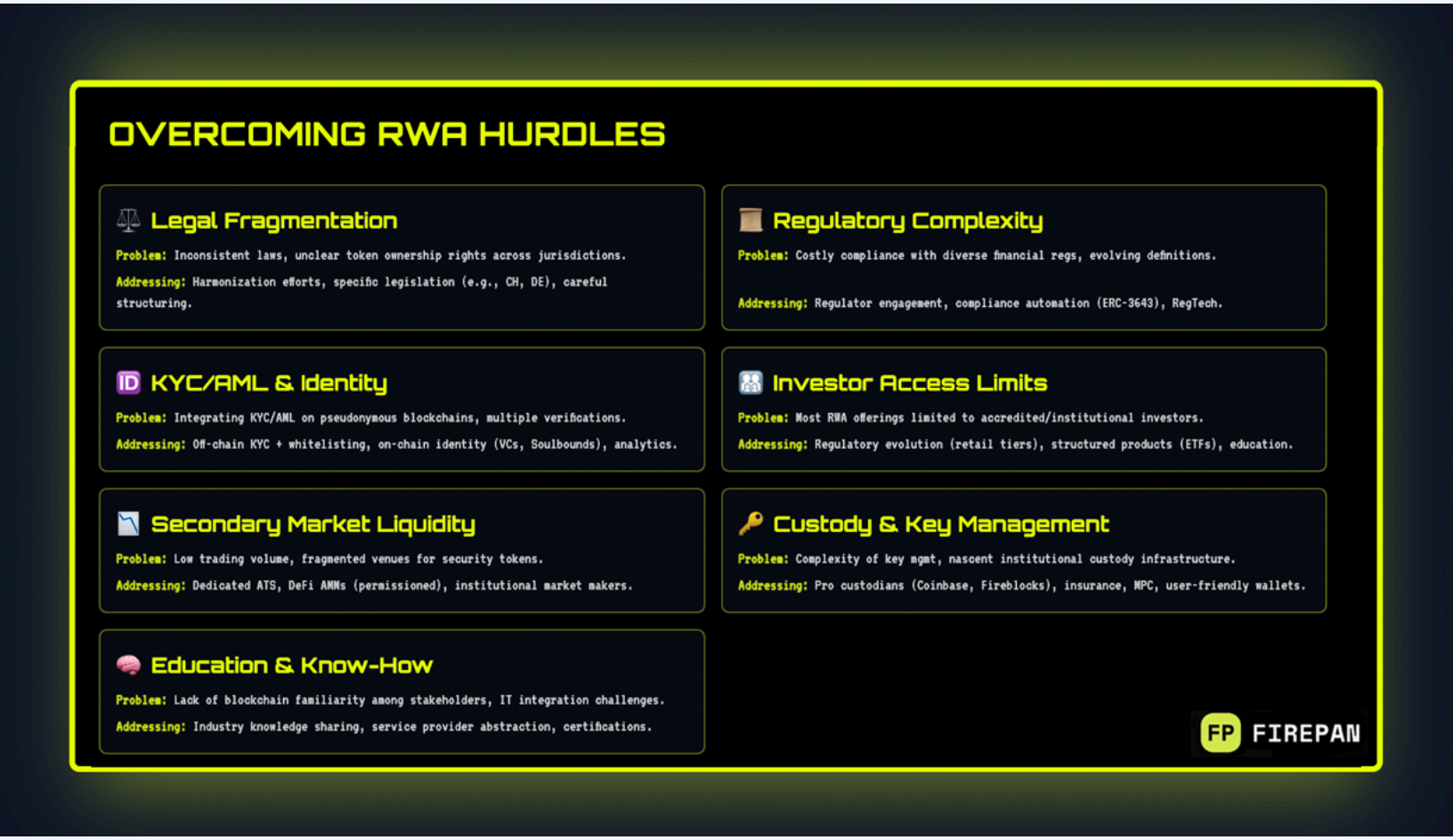
    - In permissioned networks, different model: the custody might be integrated in the network's participant structure (e.g., in SDX (Switzerland) tokenized securities, a central CSD-equivalent holds a master key; or in some permissioned blockchains, losing a key isn't catastrophic because identities are known and assets can be reissued if legally approved).

    - User-friendly tech: For broader adoption, improvements in wallet tech (social recovery wallets, hardware security modules for retail, etc.) will be needed so that individuals don't lose their life savings by misplacing a seed phrase. Companies like Ledger and MetaMask Institutional are working to adapt to security tokens (with compliance features).
      In summary, custody is both a technical and regulatory bottleneck, but it's being actively addressed by a growing digital custody industry. It's often said "institutional adoption will only go as fast as custodial solutions allow", and we are seeing that catch up now.

- **Education and Operational Know-How:** Lastly, a less tangible but critical challenge is education. Many institutional stakeholders (be it a pension fund's operations team, a transfer agent, or a regulator's staff) are not yet well-versed in blockchain operations. This can cause friction: misunderstanding how certain risks are mitigated or how to perform tasks like auditing a token supply, handling corporate actions on-chain, etc. Likewise, traditional IT systems at banks or asset managers may not integrate easily with blockchain systems. This lack of familiarity can slow adoption or lead to mistakes. To address this, early adopters are sharing knowledge: e.g., Project Guardian reports detailed lessons learned for broader industry [businesswire.com], and organizations like ISDA and ISSAt are publishing guidelines on using DLT for derivatives and securities. Service providers like Firepan also play a role in abstracting complexity – offering interfaces that feel similar to current systems so that employees can handle tokenized assets without needing to code or understand the chain's intricacies. On the retail side, educating investors about the differences (e.g., "If you lose access to your wallet, here's what happens" or "how to verify a token's legitimacy on a block explorer") is equally important to build trust. Industry groups and events (conferences on tokenization, certifications for digital asset professionals) are increasingly focusing on this educational piece.

In summary, none of these challenges are insurmountable, but they are non-trivial. The current state might be likened to the early internet – robust in concept but still working through scalability, user-friendliness, and regulatory frameworks. Encouragingly, efforts are underway on all fronts: governments are updating laws (e.g., UAE's pragmatic approach, EU's pilots, US's custody clarifications, technology is advancing (identity standards, compliance tools, better custody), and market actors are collaborating to improve liquidity and interoperability (as seen in cross-chain POCs and networks of institutions).

Addressing legal clarity, compliance integration, liquidity, and infrastructure robustness will likely be the focus of the next 2–3 years in the tokenization journey. The pace of progress suggests many of these bottlenecks will gradually diminish. As they do, tokenization will shift from early adoption to mainstream usage, setting the stage for the more visionary outcomes discussed in our final section on the future outlook.



Firepan's Vision & Role in the Ecosystem

As the industry tackles the above challenges, platforms like Firepan are emerging to accelerate tokenization through innovative, compliance-centric solutions. Firepan is positioning itself as a critical piece of the RWA tokenization infrastructure – a bridge between asset originators, the necessary compliance/custody layer, and multiple blockchains. In this section, we highlight Firepan's value proposition, its product

architecture, and how it differentiates itself to add value in the tokenization ecosystem. We also cover how Firepan is a solution that aligns with the needs of institutions and investors.

Firepan's mission is to *"transform the way real-world assets are owned, traded, and managed through blockchain technology"* [firepan.com]. The company envisions a future where all asset classes – from real estate to art to equities – can be tokenized and fractionally owned, with trading as seamless as digital asset trading today, all while *"maintaining compliance with regulatory frameworks."* [firepan.com]. This vision explicitly acknowledges that compliance is not an afterthought but a core design principle. Firepan aspires to become the leading infrastructure provider powering tokenization across the entire "$867 trillion real-world asset market" [firepan.com]. Firepan is aiming for scale by providing rails that could handle the tokenization of all (or a significant portion of) global assets over the long term.

Firepan offers software (available via web interface and APIs) that simplifies the end-to-end tokenization process for institutions, businesses, and eventually individuals [firepan.com]. The platform can be thought of in modules:

- **Tokenization Module:** This is where an asset is converted to digital tokens. Firepan provides tools to register the asset's details (for example, property data, legal documentation, valuation) and then generates smart contracts that will represent ownership of that asset on-chain. The platform *"creates digital tokens representing fractional ownership"* in a straightforward workflow [firepan.com]. This process includes asset verification – Firepan assists all parties with tools for due diligence to verify things like property title or fund NAV before tokenizing [firepan.com]. By having tools built-in steps for legal and technical due diligence, Firepan ensures that the token creation is robust and the tokens are indeed backed by the asset as claimed.

- **Compliance & Identity Layer:** Firepan's infrastructure has compliance baked in. The platform leverages smart contracts that enforce rules – e.g., limiting token transfers to verified investors, embedding lock-up periods, or automating checks against sanction lists. Firepan offers *"automated compliance"* such that *"smart contracts ensure all transactions comply with local regulations and property laws based on the issuer's defined needs."* [firepan.com]. Firepan can employ standards like ERC-20/1400/3643 under the hood, issuing tokens that check an on-chain whitelist or require an off-chain signature for approval of transfers. Firepan integrates with identity verification providers for an option to KYC investors during onboarding, storing their verified status. Because of this, asset issuers using Firepan have flexibility and don't need to separately build additional

systems – it's part of the platform's core. This compliance-first design is crucial to its appeal for institutions who cannot compromise on regulatory requirements.

- **Custody & Asset Management:** Recognizing that many clients will not want to self-custody tokens, Firepan partners with licensed custodians and trust companies to handle the underlying assets and the tokens. Firepan uses *"licensed partners [can] handle custody, compliance, and issuance"* [firepan.com]. Firepan does not directly hold client assets, but instead integrates with qualified custodians who hold the real asset (or legal title) in trust and optionally the private keys for tokens in secure custody if clients desire. Additionally, Firepan provides portfolio management tools so that an issuer or investor can track token holdings, see cap tables, manage distributions, etc. This includes a dashboard showing metrics and other relevant information.

- **Trading & Liquidity Module:** Firepan's platform facilitates a "liquid marketplace for RWA tokens with institutional-grade security and settlement." [firepan.com]. While Firepan is not a centralized exchange, it does provide an interface or network for secondary transfers – connecting with decentralized platforms or using an order-matching for Firepan users on 3rd party systems. The goal is to enable 24/7 trading of tokens so that issuers and investors have liquidity options. Firepan's stats highlight improvements like *"62% reduced transaction time"* and *"3.5× increased liquidity"* for real estate tokens [firepan.com], creating a marketplace that significantly speeds up transactions and finds more buyers than traditional processes. Settlement on Firepan's marketplace is near-instant (depending on the blockchain), addressing a pain point in traditional secondary markets.

- **Multi-Chain Support:** Firepan is blockchain-agnostic – it supports multiple Layer-1s (Ethereum, etc.) and Layer-2s or permissioned chains, depending on client needs. This is critical because some clients may prefer a public chain for transparency, while others might require a permissioned environment for privacy. Firepan's developers section and docs can guide how to issue tokens to different networks. The platform can abstract this by using a single API and then deploying to the chain of choice. Multi-chain capability provides interoperability: e.g., Firepan could tokenize an asset on Ethereum but also mirror it on Polygon for lower fees, using bridges – giving wider reach and user choice. Firepan's *"Developers"* portal [firepan.com], provides APIs/SDKs for integration (e.g., an enterprise could integrate Firepan's tokenization engine into its existing systems via API).

Firepan understands asset issuer's needs for compliance and security. The platform is built such that an issuer can "convert physical assets into digital tokens with legal compliance and asset verification" from the outset [firepan.com]. This is a recognition that institutions will not sacrifice compliance for innovation – they need both. Firepan's approach includes:

- **Legal Entity Support:** Firepan is software and provides 3rd party tools for issuers to navigate their existing legal setup (e.g., creating an SPV to hold an asset if needed, or drafting the terms and conditions for token holders that align with relevant law). Firepan does not offer investment, legal, tax, or business advisory services, but rather provide the repository where those legal entity docs exist.

- **Auditability:** Firepan ensures that every token issuance is auditable – maintaining on-chain transaction records for linking token IDs to real-world asset IDs, providing dashboards for auditors/regulators to see the token cap table. This transparency *within a permissioned context* gives comfort that nothing is being hidden or done off-books.

- **Security Measures:** Firepan is software infrastructure that handles potentially large financial value, so security is key. This includes smart contracts audited by third parties, multi-sig approval for any administrative actions on tokens, encryption of sensitive data, and resilient architecture.

- **Trusted Partnerships:** By partnering with licensed custodians, compliance tools, analytics solutions, and more, Firepan ensures that the necessary regulated activities are covered by experts. For example, if a real estate asset is tokenized, a licensed trustee might hold the deed in escrow – Firepan integrates that trustee's oversight so that token holders are confident their rights are protected.

Firepan Is Your Competitive Edge. There are several tokenization platforms in the market, but Firepan's differentiators include:

- **Holistic Platform:** It offers an all-in-one solution – from issuance to trading – whereas some competitors focus only on issuance (token creation) and others only on trading/settlement. Firepan's comprehensive approach reduces friction; clients don't have to cobble together multiple vendors.

- **Institutional Focus with User-Friendly Interface:** Firepan is designed for institutional requirements (high security, compliance, scalability) but with an interface and process that aims to be user-friendly. This usability is crucial in an

industry often bogged by technical complexity.

- **Global and Multi-Asset Reach:** Firepan is not limited to one niche and can support multiple asset categories (real estate, precious metals, commodities, funds, etc.) [firepan.com]. This broad capability is attractive to a diversified financial institution that might want to tokenize various assets all through one provider.

- **Bridging TradFi and DeFi:** Firepan's role can be seen as bridging asset originators (like a real estate firm or a private equity fund) with the blockchain world. It offers integration with traditional systems – for example, an issuer could plug Firepan into their existing investor portal or CRM to start offering tokenized shares to their clients without the clients needing to learn about blockchain intricacies. Simultaneously, Firepan can connect to blockchain-based ecosystems, perhaps enabling features like allowing tokens to be used in DeFi lending or connecting to stablecoin payment rails for distributions.

Firepan software infrastructure emphasizes being *compliance-first* which aligns with regulatory expectations that new innovations build in safeguards. By doing so, Firepan effectively lowers the barrier for traditional institutions to try tokenization – they can rely on Firepan's built-in compliance from 3rd party solutions that aligns with their own internal process and solutions. In the broader ecosystem, Firepan serves as an on-ramp for asset originators: a real estate company, for instance, can tokenize properties via Firepan and instantly have those tokens ready to trade or integrate with other platforms. Firepan feeds high-quality assets into the tokenized market. Firepan also provides the financial institution with direct access to their investors. The Firepan platform can aggregate investors who are looking for tokenized opportunities, making it easier for issuers to engage existing buyers and interface with them directly, while also potentially finding new ones. In essence, Firepan is creating a network effect: more issuers attract more buyers, which in turn attracts more issuers, etc.

To illustrate Firepan's ecosystem approach: imagine a scenario – a private real estate fund uses Firepan to tokenize limited partner units. Firepan's software enables the fund to verify the properties and validate the fund structure, issuing tokens on a chosen blockchain, ensuring only verified accredited investors purchase them. Those tokens can then automatically be listed on Firepan's marketplace or even be made available to partner exchanges (through APIs). A buyer on Firepan's platform could log in, undergo KYC once, and then seamlessly invest in that fund, a tokenized gold product, and a tokenized private credit offering – diversifying their portfolio – all without leaving the Firepan software interface.

Firepan is a trusted partner for institutions venturing into tokenization. By using Firepan's platform, an institution signals it is using best-in-class infrastructure, which can be reassuring to their board, clients, and regulators.

Firepan has a vision of where the tokenization industry needs to go: making tokenization *boringly routine* and safe, rather than exotic and risky. Its role is to industrialize and simplify tokenization, providing the pipes and tools so that any institution can tokenize assets as easily as issuing electronic securities today – but with the enhanced benefits of blockchain. Firepan is the software infrastructure that can scale the tokenized RWA ecosystem from the current billions to the forecasted trillions by bringing more assets and investors on-chain in a secure, compliant manner.

Future Outlook

Looking ahead to 2030 and beyond, we anticipate that many of the trends in motion today will coalesce into a transformed financial landscape – one where tokenization is standard, and real-world assets freely move between traditional and blockchain-based systems. Here we outline possible scenarios and trends for the next 5+ years, considering full industry maturation, the interplay of public vs private chains, the influence of AI on tokenization, and the emergence of new asset classes and innovations.

Mainstream Adoption and Full Tokenization: By 2030, it's very plausible that tokenization will have moved from niche to norm. *"We believe we are approaching an inflection point"* where blockchain's promise is realized in billions of users and trillions of value, as Citi's report said [thetokenizer.io]. In practice, this could mean:

- A significant percentage of new issuances of financial instruments are done on blockchain rails. For example, new bonds (both government and corporate) may commonly be issued as native digital bonds recorded on a distributed ledger (perhaps on an institutional network like Canton or directly on public Ethereum, depending on privacy needs). Some jurisdictions might even mandate or strongly encourage this for efficiency – similar to how dematerialization of paper securities became mandatory in many markets decades ago.

- Existing assets migrating on-chain: We could see stock exchanges offering tokenized representations of publicly listed equities that can trade 24/7 internationally, complementing traditional hours. Real estate title offices might fully transition to blockchain-based registries, making property tokenization

essentially the default way to manage real estate ownership (as envisioned in Dubai's ongoing projects [tokeny.com].

- 10% of Global GDP on-chain: BCG's 10% of GDP by 2030 [ledgerinsights.com] could very much come to pass. Global GDP ~ $100T, so $10T in assets on-chain – whether through securities, stablecoins, or central bank digital currencies – would mark a tipping point where blockchain is deeply embedded in financial infrastructure. A world where, for instance, a company raising capital might simultaneously issue shares on a traditional exchange and as tokens for broader distribution, catering to different investor preferences, but all interoperable.

- Institutional and Retail Use: Institutions by 2030 will likely treat tokenized assets as just another (and maybe preferred) format. We might see major asset managers with entire tokenized fund lineups for retail (some offering daily liquidity via AMMs), banks offering tokenized deposit accounts or loan participations to clients, etc. Retail investors might hold a single wallet that contains a mix of stocks, bonds, and alternative assets – all tokenized – alongside their digital cash. The ease of fractionalization could mean an average person's portfolio includes tiny slices of assets previously unattainable (e.g., 1/1000th of an office building, 0.1% of a private equity fund, etc.), improving diversification and inclusion.

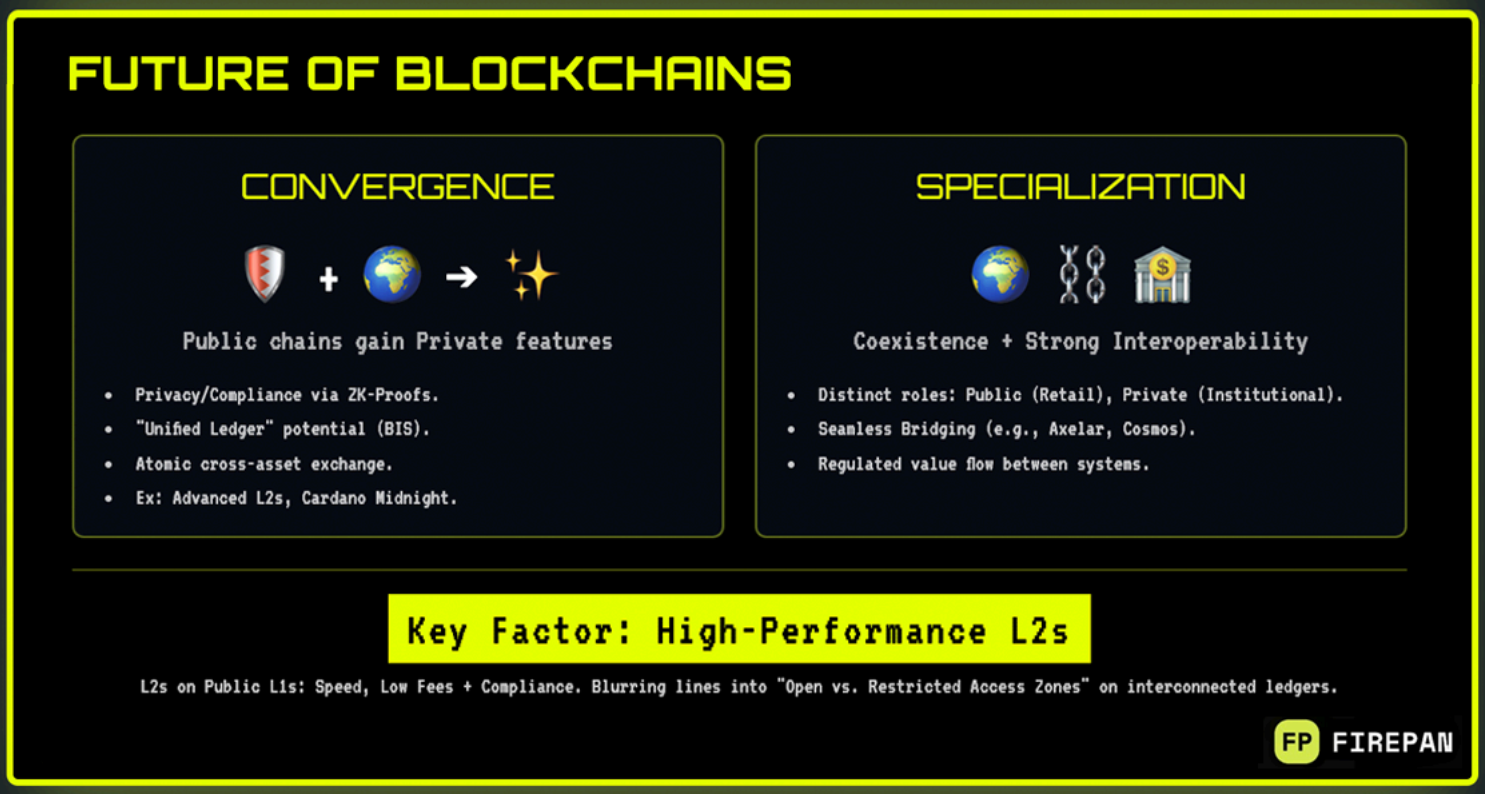
Currently, we see a dichotomy - permissioned chains for institution-only use vs. public chains for broader access. By 2030, the line may blur. Two plausible outcomes:

- **Convergence:** Advances in technology such as zero-knowledge proofs and robust identity systems could allow public blockchains to offer privacy and compliance controls equivalent to private systems. For example, one can imagine Ethereum (or Ethereum L2s) as the common settlement layer for most assets, with ZK-proofs ensuring transaction details are private but compliance can be verified by authorized parties. This could reduce the need for separate permissioned networks. Projects like Midnight Network and others are already heading in this direction of combining public verifiability with privacy [midnight.network]. If successful, we might have a scenario where *even central banks and major stock exchanges are comfortable on public chains*, given they can enforce their rules and keep sensitive data confidential. Under convergence, the unified ledger vision by BIS could be realized: one network (or interoperable network-of-networks) where central bank money, commercial bank money, and all securities coexist and can be exchanged atomically [bis.org]. This would dramatically increase efficiency – imagine instantaneous DvP for any trade, cross-asset smart contracts (e.g., a real estate token automatically pays its rental income to

stablecoin holders, executing the equivalent of a securitization waterfall with no intermediary).

- **Specialization:** Alternatively, public and private chains might continue to co-exist, each serving distinct purposes. Public chains might handle retail-facing assets, niche assets, and serve as innovation sandboxes (with DeFi, open access, etc.), whereas private/consortium chains remain dominant for large-scale institutional flows due to conservative preferences or specific needs (like the banking consortium led Canton network for bonds and syndicated loans). However, even in this scenario, interoperability would likely be solved. One can envisage seamless bridging – using protocols like Axelar, Polkadot, Cosmos – so that assets can move from a permissioned context to a public one when appropriate (and vice versa). For example, a bond could trade among banks on a permissioned ledger during issuance and seasoning, then a portion could be transferred to a public chain for broader trading to accredited investors globally. Regulators might insist on ring-fencing certain activities to permissioned ledgers (for systemic stability), but the value flows between systems would be much smoother than today's siloed approach.

- **Dominance of High-Performance L2s:** It's worth noting that Ethereum's roadmap plus L2s might yield public networks that can handle tens of thousands of TPS with low fees. If they integrate identity and compliance, they could become the backbone for even regulated markets. But some predict a future where even national financial market infrastructures run on consortium L2s that settle to public L1s periodically – giving the best of both worlds. By 2030, we might talk less about "public vs private" and more about "open vs restricted access zones" on a continuum of interconnected ledgers.



AI Integration in Underwriting, Issuance, and Management: The 2020s have seen AI (especially machine learning and automation) revolutionize data analysis. By 2030, AI will likely play a substantial role in the tokenization value chain:

- **Underwriting & Credit Analysis:** AI algorithms could assess the quality of assets to be tokenized much faster and perhaps more impartially than humans. For example, an AI could analyze property data, rental yields, market comps, and even satellite imagery to underwrite a real estate token offering (evaluating risk and appropriate pricing). Similarly, AI models might evaluate creditworthiness of loan portfolios being tokenized (using vast datasets of borrower behavior, macro trends). This could lower the cost and time of due diligence, making it feasible to tokenize assets at scale that previously would be too costly to analyze individually (like millions of micro-loans, or thousands of small properties).

- **Automated Structuring & Issuance:** AI could help structure tokenization deals optimally. For instance, an AI system might determine the ideal tranche structure for a tokenized bond offering to appeal to different investor segments, or automatically ensure the smart contract terms align with regulatory requirements by cross-referencing legal databases (essentially an AI legal assistant). One could

imagine an AI that the issuer interacts with: “I want to tokenize this $100m pool of auto loans,” and the AI suggests how many tranches, expected yields, attaches relevant risk disclosures, and even generates the smart contract code – all in minutes.

- **Personalized Portfolio Assembly:** From an investor perspective, AI agents might curate tokenized asset portfolios tailored to individual risk/return profiles, continuously rebalancing them. For example, an AI advisor could allocate someone’s money across dozens of tokenized assets (some real estate, some private credit, some commodities) to achieve a specific exposure, and do so by interacting with various token marketplaces in real-time. This is like robo-advisors today, but with a far broader palette of assets, many only accessible because of tokenization. AI could also simulate outcomes, providing comfort to investors (e.g., showing how a tokenized portfolio would have performed through historical scenarios).

- **Risk Monitoring and Compliance via AI:** On the regulatory side, AI will likely be used to monitor tokenized markets. AI algorithms can watch blockchain transactions for patterns indicative of fraud or risk build-up. Because blockchain provides rich, structured data, AI can be very effective (as we see even today in on-chain analytics spotting hacks or market manipulations). By 2030, regulators might have AI “agents” monitoring systemic risk, who can automatically flag unusual concentrations (say a stablecoin accumulating too much illiquid collateral) or even intervene in smart contracts if necessary to neutralize threats (a controversial idea, but technically possible if built in).

- **AI-operated assets:** An intriguing possibility is AI originating assets itself. For instance, could AI underwrite loans directly to borrowers (using on-chain identity and credit data), issue tokenized loan notes, and manage the lending pool – all autonomously? Projects in DeFi are exploring “autonomous agents” that manage vaults or portfolios. Extend that to RWA and one could see autonomous securitization vehicles that take in tokens (like stablecoins) and output RWA tokens (like loan tokens) with AI managing the matching and risk – essentially decentralized, AI-run banks or insurers. This blurs the line between AI and tokenization, creating a world where AI-driven DAOs hold tokenized real assets and optimize their use.

By 2030, many assets still considered unconventional to tokenize today may become common:

- **Art and Collectibles:** The tokenization of fine art, collectibles, vintage cars, etc., could become a major asset class of its own. We already see NFTs representing digital art; by 2030, fractional tokens of Picasso paintings or rare collectibles may be a standard investment product, with art investment DAOs commonplace. These would benefit from the 24/7 global market and fractional access enabled by tokenization.

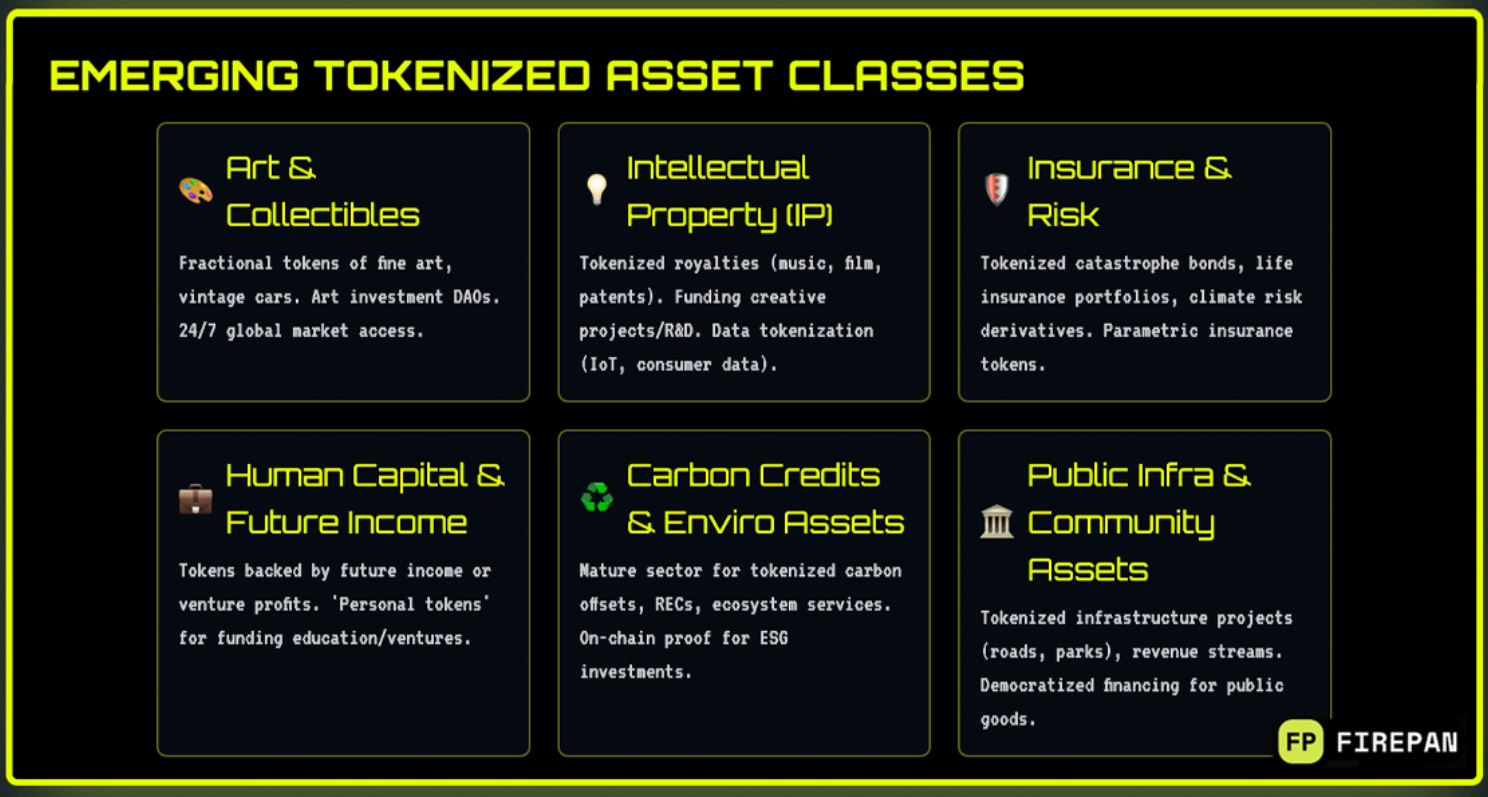
- **Intellectual Property (IP):** IP rights – whether royalties from music and film, patents, or trademarks – can be tokenized to allow investors to fund creative projects or R&D in exchange for a share of future revenue. We might see IP exchanges where song catalogs are traded via royalty tokens, giving artists upfront funding and investors a new income stream. In fact, by 2030, even data might be tokenized: individuals or companies could package their data (e.g., IoT sensor feeds, consumer behavior data streams) into tokens and sell rights to it, with privacy ensured by zero-knowledge proofs. This could birth a new data economy where tokens encapsulate everything from personal health data (sold in a controlled way to research institutions) to enterprise data.

- **Insurance and Risk:** Large insurance risks (catastrophe bonds, life insurance portfolios, climate risk derivatives) could be tokenized. This would let a broader set of investors take on insurance risk for high yields, helping distribute risk. We might see parametric insurance tokens that automatically pay out based on certain triggers (with oracles feeding weather or disaster data to smart contracts). For example, communities could insure themselves by issuing tokens that pay out if rainfall is below a threshold (drought insurance) – buyers of these tokens provide capital and get a return if no drought occurs, essentially functioning as mini-insurers.

- **Human Capital and Future Income:** Perhaps more radically, tokenization could extend to human capital – individuals might issue tokens backed by their future income or a share of a future venture's profits. Already, experiments with "personal tokens" have occurred on a small scale. In 2030, a talented student might fund their education by tokenizing a percentage of their future earnings to investors, handled via smart contract with income data or tax data feeding in to automate payments. This is akin to income share agreements, but on a global token market.

- **Carbon Credits and Environmental Assets:** While carbon credits are already being tokenized now, by 2030 this could be a very mature sector. Every carbon offset, renewable energy certificate, or even ecosystem service (like a token that represents one ton of preserved rainforest) might trade in token form. This would bring transparency and uniform standards to what is currently a fragmented market. It aligns with global ESG investing trends; investors might demand on-chain proof of their impact investments, and tokenization provides that traceability.

- **Public Infrastructure and Community Assets:** Cities or communities might tokenize infrastructure projects (roads, parks) or revenue streams (toll roads, stadium ticket revenues) to raise funds directly from citizens or global investors. This democratizes financing of public goods and could align incentives (token holders benefit from project success). By 2030, we might see municipal bonds largely replaced by tokenized infrastructure tokens that come with both governance rights (citizens voting on projects) and revenue sharing.



By 2030, the line between “crypto” and “traditional finance” may have faded. Tokenized assets will be accessible through regular banking apps and brokerage accounts, as the back-ends of those financial institutions adopt blockchain rails. We may have CBDCs (Central Bank Digital Currencies) widely in use – already, dozens of central banks are exploring them. If CBDCs exist (or regulated bank deposit tokens like JPM Coin become common), they form the digital cash leg that complements tokenized assets, enabling near-instant, risk-free settlement for any trade. The synergy of tokenized money and tokenized assets is powerful: you achieve true DvP, atomic swaps, and can program complex conditional transactions (e.g., payment streams that stop or start automatically based on performance metrics, all enforced on-chain).

Moreover, tokenization might affect macro trends: It could increase liquidity and velocity of capital in the economy by reducing frictions. It might also pose new questions for regulators about financial stability (if everything is more liquid, could that cause more volatility? Or does dispersion of assets to more holders make the system more stable?). Central banks may even use on-chain data as a new tool for monitoring economic activity in real-time (some forms of tokenization allow insight into flows that was not possible with analog instruments).

Of course, the future is uncertain. We should also consider potential risks or stumbles on the road to 2030:

- The possibility of a major technology failure or hack in a tokenization platform that shakes confidence (imagine a bug that affects a widely used smart contract standard leading to a loss).

- Regulatory overreaction or fragmentation: perhaps some jurisdictions double down on walled-garden approaches or ban certain public chain usage due to perceived risks, leading to a split ecosystem.

- Adoption hurdles: If the industry fails to significantly improve user experience, the mainstream may be slow to adopt. The tech must become invisible to end users.

- Interoperability not realized: a risk that many separate networks crop up and don’t talk to each other, which could trap liquidity in silos if not resolved.

- Macroeconomic factors: If interest rates, for instance, normalize or if certain asset classes fall out of favor, it could dampen specific tokenization segments (though tokenization overall is somewhat agnostic – it’s a method, not an asset class itself).

Nonetheless, given the momentum, the base case for 2030 is optimistic. Industry predictions of multi-trillion tokenization markets [ledgerinsights.com /midnight.network] suggest that within this decade, tokenization will achieve widespread adoption, fundamentally altering how assets are issued and traded. We foresee a world where financial markets are more global, more accessible, more efficient, and operate 24/7, with blockchains (public or private or a blend) as the underlying fabric. Asset management could become more dynamic and personalized due to both tokenization and AI. Capital finds its way to opportunities across the world seamlessly, and even things like micro-investments and micro-finance flourish because frictional costs are so low.

In conclusion, the journey from now to 2030 will be about integrating technology, regulation, and market practices to unlock the enormous potential of tokenization. Firepan and its peers will play a crucial part in this by building the infrastructure and trust needed to bring ever more assets and participants on-chain. If the current trajectory holds, by 2030 we will not be talking about the "tokenization industry" as separate – it will simply be part of the financial industry, as commonplace as electronic trading or online banking, fulfilling the vision of a more inclusive and efficient financial system.

This report has drawn on a range of industry research and data points to underpin its analysis – from Boston Consulting Group's $16T forecast [ledgerinsights.com] to Citi's 80x growth projection [thetokenizer.io], and market size data from platforms like RWA.xyz (showing $15B+ in RWAs by 2024) [investax.io]. We also referenced live cases and statements from major institutions (e.g., BlackRock's fund growth [cointelegraph.com], JPMorgan's $300B repo volume [ledgerinsights.com], Franklin Templeton's $380M on-chain fund [cryptoslate.com]. These underscore both the momentum and credibility of the tokenization trend. Additional sources like Coinbase's 2025 Crypto Outlook [marketsmedia.com], Market Media's analysis [marketsmedia.com], and Tokeny/WEF insights on ecosystems and challenges [weforum.org] provided context on trends and hurdles. Charts included (such as the one illustrating tokenized asset growth by category) visually depict how private credit, treasuries, etc., compose the current market [marketsmedia.com / investax.io].

By harnessing these insights and looking toward signals of the future, we present a comprehensive picture of The State of Tokenization and Real World Assets – an evolving landscape that Firepan and others are actively shaping as we move toward a tokenized economy. The stage is set for the coming years to realize the full promise of this technology, transforming finance in the process.

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