

Real-World Assets & Tokenization: Bridging TradFi and DeFi

Standalone Technical Lecture

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University Lecture Series

March 5, 2026

1. Tokenization
Fundamentals

2. Stablecoins
Deep Dive

3. Security Token
& Compliance

4. Real Estate & Bond
Tokenization

5.

Learning Objectives

- Understand tokenization mechanics and real-world asset classes
- Analyse stablecoin designs: fiat-backed, crypto-backed, algorithmic
- Evaluate security token standards and compliance frameworks
- Assess real estate and bond tokenization case studies
- Survey the RWA ecosystem, institutional adoption, and future outlook

Prerequisites

- Lessons 1–5: Blockchain fundamentals, smart contracts, DeFi
- Basic familiarity with traditional finance (bonds, real estate, securities)

90 minutes — 5 sections — ~55 frames — Prerequisite: Lessons 1–5

Durat

- 1 Tokenization Fundamentals
- 2 Stablecoins Deep Dive
- 3 Security Tokens & Compliance
- 4 Real Estate & Bond Tokenization
- 5 RWA Ecosystem & Future

through 5 sections from tokenization fundamentals to the future of the RWA ecosystem

By the end of this lecture, you will be able to:

- 1 **Explain** how real-world assets are tokenized and the role of oracles
- 2 **Analyze** stablecoin reserve models and their transparency mechanisms
- 3 **Compare** security token frameworks (ERC-3643, on-chain KYC/AML) with utility tokens
- 4 **Evaluate** real estate and bond tokenization platforms (RealT, Centrifuge, Ondo)
- 5 **Assess** the regulatory challenges and institutional adoption drivers for RWA

taxonomy levels: Remember → Understand → Apply → Analyze → Evaluate → Create

Blo

Section 1: Tokenization Fundamentals

What is tokenization, asset classes, token standards, and the fractionalization revolution

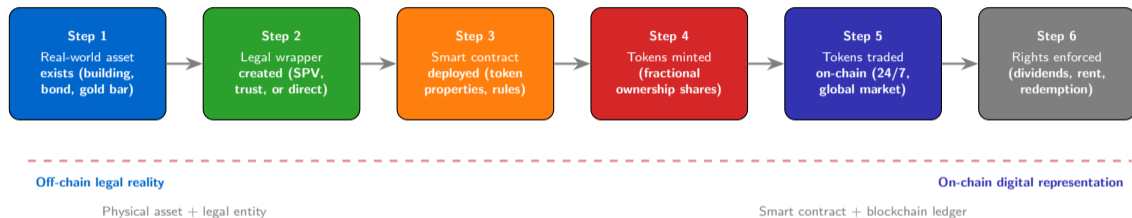
What You Will Learn

- What tokenization means and how it digitizes ownership
- Tokenizable asset classes: real estate, bonds, commodities, art
- Token standards: ERC-20, ERC-721, ERC-1155, ERC-3643
- Benefits: fractional ownership, 24/7 markets, global access

Frames in This Section

- Frame 5: What is Tokenization?
- Frame 6: Tokenizable Asset Classes
- Frame 7: Token Standards for RWA
- Frame 8: ERC-20 Asset Token Contract (Code)
- Frame 9: Fractionalization Mechanics
- Frame 10: Benefits of Tokenization
- Frame 11: Challenges of Tokenization
- Frame 12: The Oracle Problem for RWA
- Frame 13: Tokenization Market Map
- Frame 14: Section 1 Summary

What is Tokenization?



creates a digital twin of asset ownership – the legal wrapper ensures the token conveys real legal rights

Tokenizable Asset Classes

Real Estate (\$330T)

Residential, commercial, REITs
Fractional ownership: \$50 min
Largest tokenizable asset class

Bonds & Fixed Income (\$130T)

Government, corporate, T-bills
T+0 settlement vs T+2 traditional
BlackRock BUIDL, Franklin Templeton

Commodities (\$100T+)

Gold (PAXG, XAUT), oil, agriculture
Verifiable supply chain on-chain
Eliminates paper gold counterparty risk

Private Credit (\$1.5T)

Invoices, trade finance, structured
Transparent risk assessment
Centrifuge, Maple Finance, Goldfinch

Art & Collectibles

Fine art (Masterworks), luxury goods
Wine, classic cars, memorabilia
Democratized alternative assets

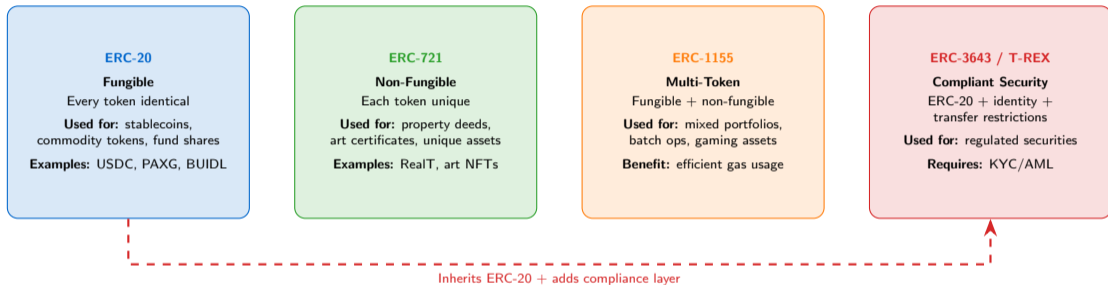
Carbon Credits & ESG

Voluntary carbon markets, RECs
Programmable retirement on-chain
Toucan Protocol, KlimaDAO

Total Addressable Market: \$500T+ in global assets

tokenizing 1% of global real estate (\$330T) would create a \$3.3T on-chain market – larger than all of DeFi today

Even



ERC-3643 is the standard adopted by most security token platforms – it adds identity verification and transfer restrictions to ERC-20

```
1 // Tokenized Real Estate Fund
2 contract RealEstateFund {
3     string public name =
4         "NYC Property Fund";
5     string public symbol = "NYCPF";
6     uint8 public decimals = 18;
7     uint256 public totalSupply;
8
9     mapping(address => uint256)
10         public balanceOf;
11
12     address public manager;
13     uint256 public navPerToken;
14
15     constructor(uint256 supply) {
16         manager = msg.sender;
17         totalSupply = supply;
18         balanceOf[msg.sender] = supply;
19     }
20
21     function updateNAV(
22         uint256 newNAV
23     ) external {
24         require(msg.sender == manager);
25         navPerToken = newNAV;
26         emit NAVUpdated(newNAV);
27     }
28 }
```

How This Works

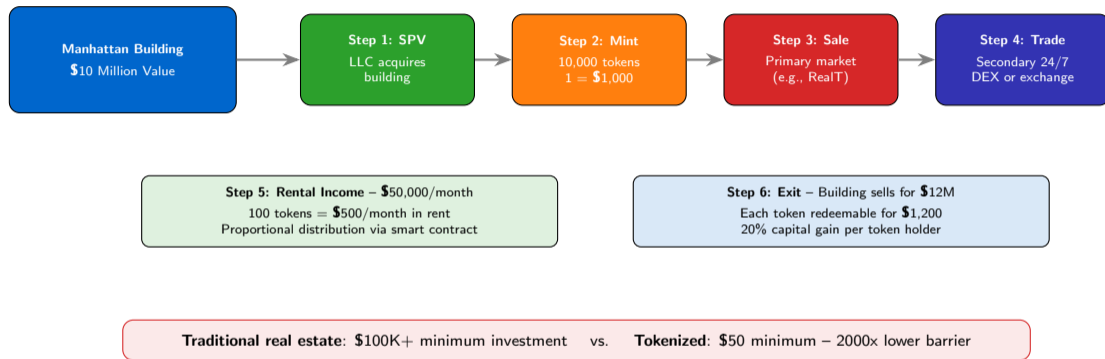
- **Token = Fund Share:** Each token represents a fractional ownership share in the NYC Property Fund
- **NAV Updates:** Fund manager calls `updateNAV()` to reflect current property valuation
- **balanceOf:** Tracks each investor's fractional ownership on-chain
- **Transfer:** Standard ERC-20 transfer enables secondary market trading 24/7
- **Dividends:** Rental income distributed via a separate distribution function (not shown)

Key Design Patterns

- Manager role for privileged operations
- On-chain state reflects off-chain asset value
- Transparent, auditable ownership ledger

This

simplified contract shows the core pattern: tokens represent ownership shares, manager updates NAV, holders can transfer freely



is the most transformative aspect of tokenization – it turns illiquid assets into liquid, accessible investments

Benefits of Tokenization

24/7 Global Markets

Trade at midnight on Sunday
No market close, cross-border access
Always-on liquidity

Fractional Ownership

\$50 minimum vs \$100K+ traditional
Democratized access to all asset classes
Retail investors participate globally

Instant Settlement

T+0 on-chain vs T+2 equities
vs T+3 real estate traditional
Atomic swap eliminates counterparty risk

Programmable Compliance

KYC/AML enforced by smart contract
Auto-dividend distribution
Regulatory rules embedded in code

Reduced Intermediaries

No transfer agents, fewer custodians
Lower fees: 0.1% vs 2-5% traditional
Disintermediation of rent-seekers

Transparent Ownership

On-chain cap table, real-time audit
Immutable records of all transfers
Regulators can verify instantly

estimates tokenization could save financial institutions \$100–200B annually in back-office costs alone

McK

Technical Challenges

- **Oracle Problem:** How does the blockchain know the building's condition, occupancy, or sale price?
- **Smart Contract Risk:** Bugs can lock or drain tokenized assets worth millions
- **Scalability:** High-value assets need robust, battle-tested chains
- **Interoperability:** Tokenized assets on different chains cannot easily interact

Legal & Regulatory Challenges

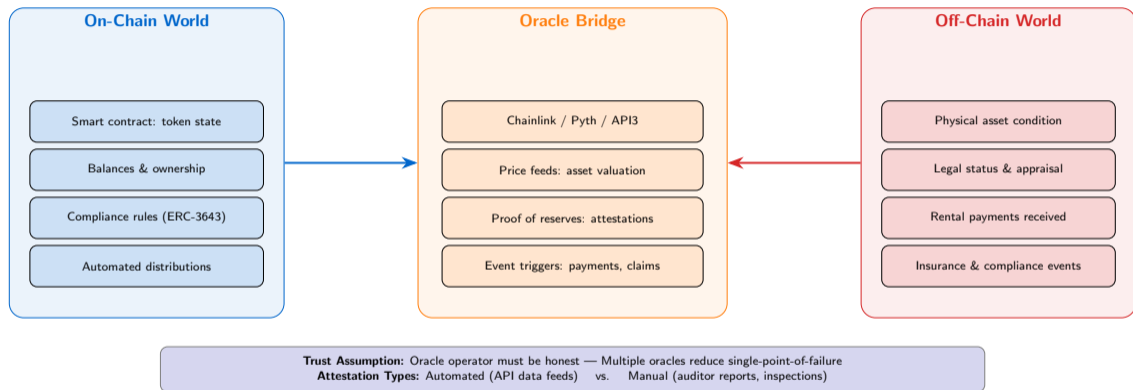
- **Legal Recognition:** Does a token convey legal ownership? Varies by jurisdiction
- **Cross-Border Complexity:** US-tokenized building sold to Japanese investor – which laws apply?
- **Bankruptcy:** If the SPV or platform fails, what happens to token holders?
- **Tax Reporting:** Capital gains, rental income, cross-border withholding



oracle problem is fundamental: a blockchain can verify on-chain state perfectly, but cannot independently verify off-chain reality

The

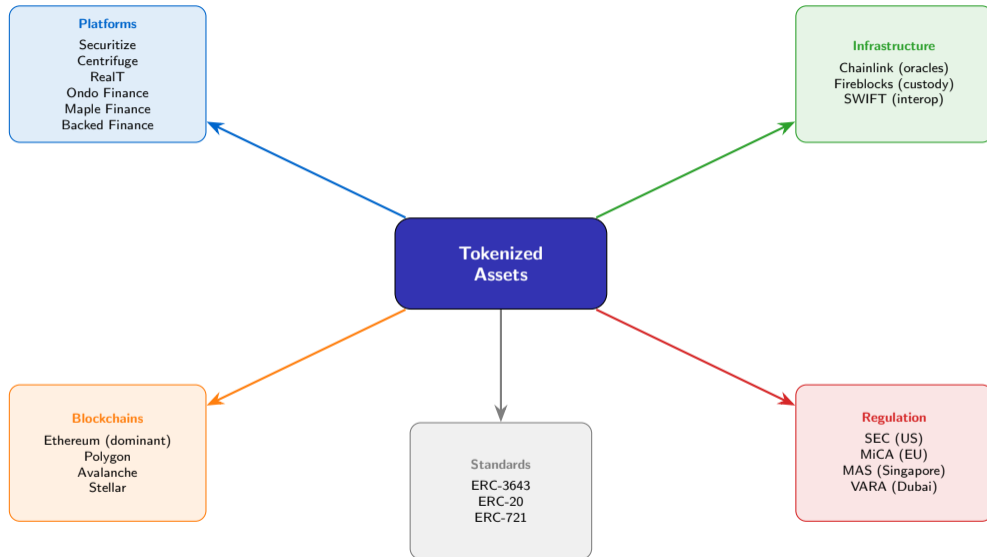
The Oracle Problem for RWA



DeFi protocols that use on-chain price feeds, RWA oracles often require human attestation – introducing trust assumptions

Unlik

Tokenization Market Map



dominates RWA tokenization with 60%+ market share – security, liquidity, and institutional trust drive this concentration

Section 1 Summary: Tokenization Fundamentals

1. Tokenization digitizes ownership rights on a blockchain via legal wrappers (SPVs) and smart contracts

2. Asset classes totaling **\$500T+** (real estate, bonds, commodities, credit, art) are candidates for tokenization

3. ERC-20 (fungible), ERC-721 (unique), ERC-1155 (hybrid), and ERC-3643 (compliant) are the key token standards

4. Fractionalization enables **\$50** minimums vs **\$100K+** traditional, unlocking global investor access

5. The oracle problem and legal recognition are fundamental challenges bridging on-chain tokens to off-chain reality

1 complete — Next: Section 2 – Stablecoins Deep Dive

Section

Section 2: Stablecoins Deep Dive

Taxonomy, mechanics, reserves, risks, and the regulatory frontier

What You Will Learn

- Stablecoin taxonomy: fiat-backed, crypto-backed, algorithmic, commodity-backed
- USDT, USDC, and DAI mechanics in depth
- Reserve attestation models and depeg risks
- The Terra/Luna collapse and regulatory response

Frames in This Section

- Frame 16: Stablecoin Taxonomy
- Frame 17: USDT (Tether) Mechanics
- Frame 18: USDC & Reserve Transparency
- Frame 19: DAI & Crypto-Backed Mechanics
- Frame 20: Collateralized Vault Contract (Code)
- Frame 21: The Terra/Luna Collapse
- Frame 22: Stablecoin Reserve Models Compared
- Frame 23: Stablecoin Market Dominance
- Frame 24: Stablecoin Regulation
- Frame 25: Section 2 Summary

Fiat-Backed (centralized, reserve-backed)

USDT (\$90B+) USDC (\$30B+) TUSD FDUSD

Mechanism: 1:1 reserves in bank accounts / T-bills

Risk: custodian failure, regulatory seizure, reserve opacity

Crypto-Backed (decentralized, overcollateralized)

DAI (\$5B+) LUSD (\$300M+) sUSD

Mechanism: lock \$150+ of crypto to mint \$100 of stablecoin

Risk: black swan liquidation cascade, oracle failure

Algorithmic (decentralized, no collateral)

UST (\$0 – collapsed) FRAX (hybrid) USDD

Mechanism: expand/contract supply via burn/mint

Risk: death spiral if confidence lost (proven by Terra)

Commodity-Backed (centralized, asset-backed)

PAXG (\$500M+) XAUT (\$400M+)

Mechanism: each token backed by physical gold in vault

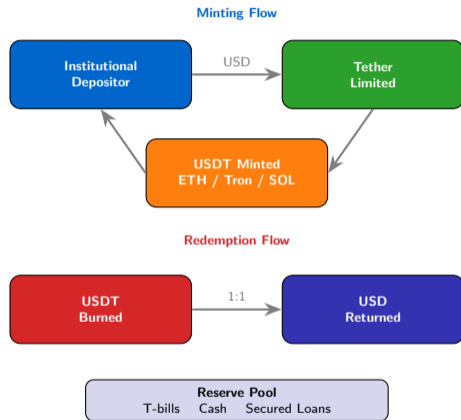
Risk: custodian risk, audit frequency

Market Share: Fiat-backed = 90%+ of total stablecoin market cap (\$150B+)

are the largest crypto use case by settlement volume – fiat-backed stablecoins dominate with over 90% market share

How Tether Works

- **Market cap:** \$90B+ (largest stablecoin)
- **Issuer:** Tether Limited (BVI)
- **Peg:** Authorized participants deposit USD, receive USDT; redeem USDT for USD
- **Reserve composition** (latest attestation):
 - ~85% US Treasury bills
 - ~10% secured loans
 - ~5% other (BTC, precious metals)
- **Controversy:** 2019 NYAG investigation, undisclosed \$850M Bitfinex loan
- **No full audit** – quarterly attestation by BDO Italia



is the most systemically important stablecoin but also the most controversial – \$90B+ in circulation, never fully audited

How Circle/USDC Works

- **Market cap:** \$30B+ (second largest)
- **Issuer:** Circle (US-regulated money transmitter)
- **Reserves:** ~80% short-term US Treasuries, ~20% cash at regulated banks
- **Monthly attestation** by Deloitte (Big 4 auditor)
- **Regulated** in US, EU (MiCA compliant), Singapore
- **March 2023 depeg:** SVB held \$3.3B of reserves – depeg to \$0.87 during collapse, recovered in 48h when Fed backstopped deposits

USDT vs USDC Comparison

Dimension	USDT	USDC
Market Cap	\$90B+	\$30B+
Attestation	Quarterly (BDO)	Monthly (Deloitte)
Reserves	T-bills + loans	T-bills + cash
Regulation	Minimal	Comprehensive
Transparency	Opaque	Transparent
Depeg History	Brief depegs	SVB \$0.87

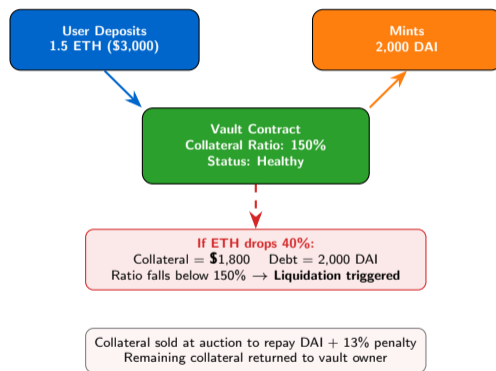
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SVB depeg showed that even well-reserved stablecoins face risk from banking system failures – diversification of reserves matters

MakerDAO/DAI Architecture

- **Decentralized stablecoin:** no single issuer
- **Vault (CDP) mechanism:**
 - Deposit ETH (or WBTC, stETH) as collateral
 - Mint DAI up to collateralization ratio (e.g., 150% for ETH)
 - Pay stability fee (interest) on outstanding DAI
 - If collateral ratio drops below threshold, liquidation auction
- **Governance:** MKR token holders set parameters (rates, ratios, collateral types)
- **PSM:** Peg Stability Module allows 1:1 swap with USDC
- **RWA vaults:** \$2B+ in real-world assets (US Treasuries, commercial loans)

Vault Mechanics



pivot to RWA collateral is historic: DAI is now backed 40%+ by real-world assets, blurring the line between DeFi and TradFi

Collateralized Vault Contract

```
1 // Simplified Collateral Vault
2 contract StablecoinVault {
3     uint256 public constant
4         MIN_RATIO = 150; // 150%
5     mapping(address => uint256)
6         public collateral;
7     mapping(address => uint256)
8         public debt;
9
10    function deposit()
11        external payable {
12        collateral[msg.sender]
13            += msg.value;
14    }
15
16    function borrow(uint256 amount)
17        external {
18        uint256 colValue =
19            collateral[msg.sender]
20            * getPrice() / 1e18;
21        require(
22            colValue * 100
23            >= (debt[msg.sender]
24            + amount) * MIN_RATIO,
25            "Below min ratio"
26        );
27        debt[msg.sender] += amount;
28        // Mint stablecoin to user
29    }
30 }
```

Overcollateralization

- MIN_RATIO = 150: Must deposit \$150 of ETH to borrow \$100 of stablecoins
- 50% buffer absorbs ETH price volatility before liquidation is needed

Collateral Ratio Calculation

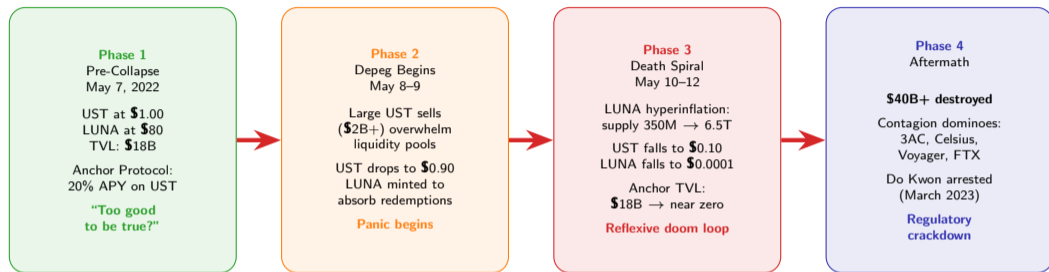
- $colValue * 100 \geq debt * 150$
- getPrice() calls Chainlink oracle for ETH/USD price feed
- If ratio drops below 150%, anyone can trigger liquidation

Governance Parameters

- MKR holders vote on MIN_RATIO and stability fee
- Different collateral types have different ratios (ETH 150%, WBTC 175%)
- Stability fee accrues continuously on outstanding debt

simplified contract demonstrates the core overcollateralization pattern – MakerDAO's production vault has 2,000+ lines of audited Solidity

The Terra/Luna Collapse



Cascade: UST depeg → LUNA hyperinflation → \$40B evaporated → 3AC/Celsius/Voyager/FTX contagion → regulatory crackdown

was crypto's Lehman Brothers moment – the death spiral proved that algorithmic stablecoins without real reserves are inherently fragile

Stablecoin Reserve Models Compared

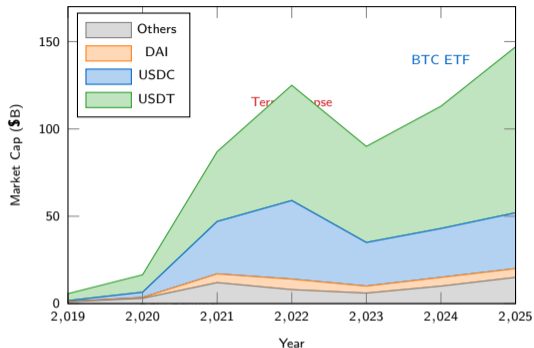
Feature	USDT	USDC	DAI	PAXG
Type	Fiat-backed	Fiat-backed	Crypto-backed	Commodity-backed
Market Cap	\$90B+	\$30B+	\$5B+	\$500M+
Backing	T-bills/cash/loans	T-bills/cash	ETH/WBTC/RWA	Physical gold
Collateral Ratio	1:1	1:1	150%+	1:1
Auditor	BDO Italia (quarterly)	Deloitte (monthly)	On-chain (real-time)	Withum (monthly)
Depeg History	Brief depegs	SVB depeg \$0.87	Brief MCD migration	None
Regulation	Minimal	US regulated / MiCA	Decentralized	NYDFS regulated
Chain Support	ETH/Tron/Solana	ETH/Solana/Base	Ethereum	Ethereum
Risk Profile	Custodian + opacity	Banking system	Oracle + liquidation	Custodian

Key Insight: Each stablecoin model trades off decentralization, capital efficiency, and regulatory compliance differently

stablecoin model has a different risk profile – there is no risk-free stablecoin, only different risk tradeoffs

Each

Stablecoin Market Dominance



Key Statistics (2024/2025)

- **Total market cap:** \$150B+
- **Daily settlement:** \$30–50B (rivaling traditional payment rails)
- **Annual on-chain:** \$10T+ (comparable to major card networks)

Market Share

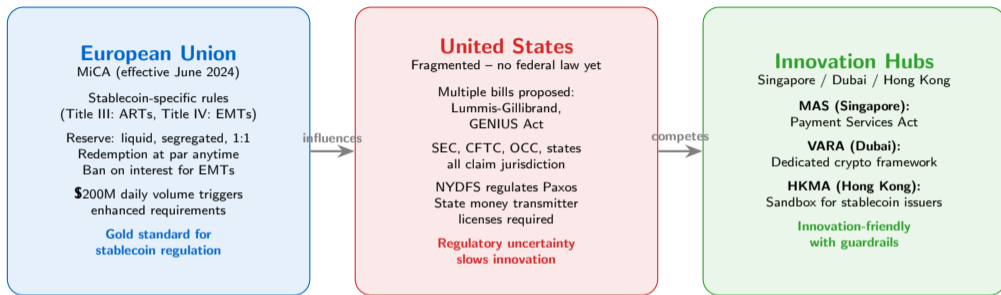
- USDT: ~60%
- USDC: ~20%
- DAI: ~3%
- Others: ~17%

Trend

USDT dominance grew during 2022–2023 bear market. USDC lost share after SVB depeg but recovering with MiCA compliance.

are the most successful blockchain use case by adoption – settling trillions annually with growing institutional and retail usage

Stablecoin Regulation



Trend: Global convergence toward reserve requirements and redemption rights – MiCA is the template

is the world's first comprehensive crypto regulation – its stablecoin rules set the global template for reserve and redemption requirements

MiCA

Section 2 Summary: Stablecoins Deep Dive

1. Stablecoins are the largest RWA category (**\$150B+** market cap) – fiat-backed dominate at 90%+ market share

2. USDT (largest, least transparent), USDC (regulated, Deloitte-audited), DAI (decentralized, overcollateralized) serve different needs

3. The Terra/Luna collapse (**\$40B** destroyed) proved algorithmic stablecoins without real reserves are fatally flawed

4. Reserve quality matters: the SVB depeg showed even well-backed stablecoins face banking system contagion risk

5. MiCA (EU) sets the regulatory template; US regulation remains fragmented across multiple agencies

2 complete — Next: Section 3 – Security Tokens & Compliance

Section

Section 3: Security Tokens & Compliance

Legal classification, the Howey test, ERC-3643, and the regulated token economy

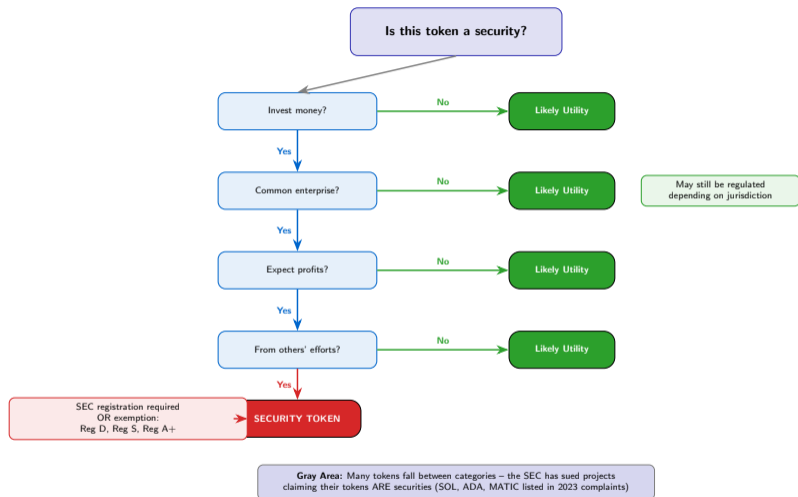
What You Will Learn

- Security vs utility token classification and the Howey test
- SEC enforcement actions and regulatory precedents
- ERC-3643 (T-REX) standard for compliant security tokens
- Regulated exchanges, legal wrappers, and on-chain KYC/AML

Frames in This Section

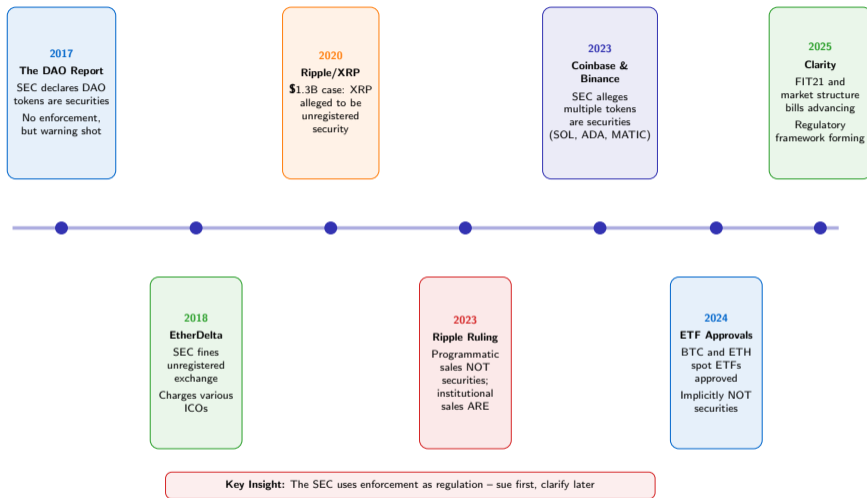
- Frame 27: Security vs Utility Tokens
- Frame 28: SEC Enforcement & Precedents
- Frame 29: The Howey Test in Practice
- Frame 30: On-Chain KYC/AML Architecture
- Frame 31: ERC-3643 Compliant Transfer (Code)
- Frame 32: Transfer Restriction Patterns
- Frame 33: Regulated Security Token Exchanges
- Frame 34: Legal Wrappers for Tokenized Assets
- Frame 35: Tokenized vs Traditional Securities
- Frame 36: Section 3 Summary

Security vs Utility Tokens



The
Howey test dates from 1946 (SEC v. W.J. Howey Co.) – it was designed for orange grove investments but now determines crypto classification

SEC Enforcement & Precedents



Ripple ruling created a split: programmatic exchange sales may not be securities, but direct institutional sales are – a nuanced precedent

Passes Howey Test (IS a Security)

- Token sale funding a project development team
- Tokens with profit-sharing from company revenue
- Tokens whose value depends on management team efforts
- Tokenized real estate with rental yield
- Tokenized equity or debt instruments

Examples: Many 2017 ICO tokens, LBRY Credits (SEC won)

Fails Howey Test (NOT a Security)

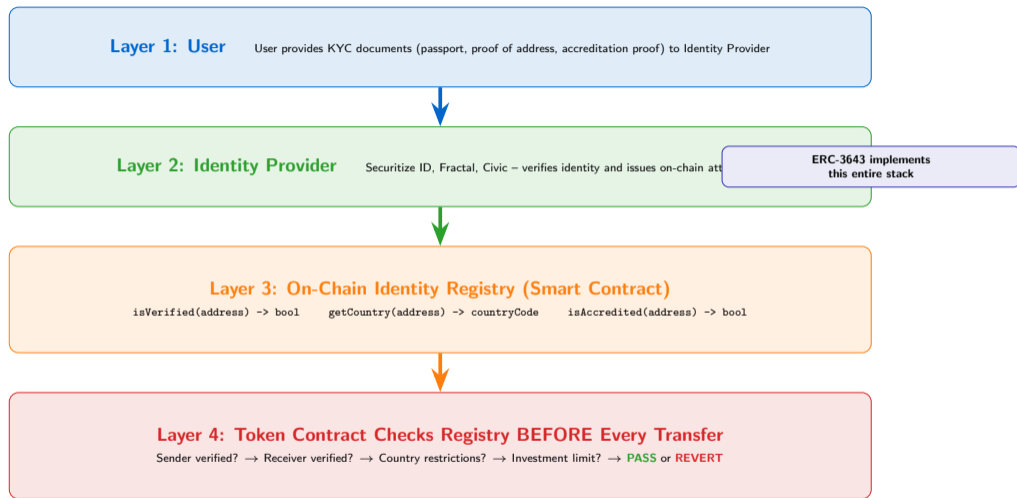
- Decentralized network tokens where no single party drives value
- Utility tokens providing access to a live, functioning product
- Governance tokens with no profit expectation (debatable)
- Sufficiently decentralized tokens (the “Hinman test” – Ethereum)
- Bitcoin (commodity per CFTC)

Examples: BTC, ETH (per SEC guidance)

Gray Zone – Most tokens live here

Classification depends on specific facts and circumstances — “Sufficient decentralization” is the key escape hatch

The distinction often comes down to “sufficient decentralization” – if no single entity drives the token’s value, it may escape security classification



On-chain KYC turns compliance from a manual process into programmable logic – every transfer is automatically checked against compliance rules

```
1 // Simplified ERC-3643 Token
2 contract SecurityToken {
3     IIdentityRegistry public
4         identityRegistry;
5     ICompliance public compliance;
6
7     mapping(address => uint256)
8         public balanceOf;
9
10    function transfer(
11        address to,
12        uint256 amount
13    ) external returns (bool) {
14        require(
15            identityRegistry
16                .isVerified(msg.sender),
17            "Sender not verified"
18        );
19        require(
20            identityRegistry
21                .isVerified(to),
22            "Receiver not verified"
23        );
24        require(
25            compliance.canTransfer(
26                msg.sender, to, amount
27            ),
28            "Compliance check failed"
29        );
30        balanceOf[msg.sender] -= amount;
31        balanceOf[to] += amount;
32        return true;
33    }
34 }
```

Identity Registry Checks

- **isVerified()**: Checks both sender and receiver have completed KYC through an approved Identity Provider
- On-chain attestation links wallet address to verified identity claim
- Identity can be revoked if KYC expires or sanctions list changes

Compliance Module

- **canTransfer()**: Enforces country restrictions, investor limits, lockup periods, and volume caps
- Modular: swap compliance rules without redeploying the token contract
- Issuer configures rules per jurisdiction

ERC-3643 in Production

- Wraps ERC-20 with a compliance layer – all standard ERC-20 functions still work
- Developed by Tokeny Solutions – 500+ deployments on Ethereum and Polygon

Transfer Restriction Patterns

Country Restrictions

Block transfers to/from sanctioned countries (OFAC list)



Transfer Volume Limits

Max transfer size per period (anti-money laundering)



Investor Limits

Max token holders (Reg D 506(c): accredited only, max 2000 before SEC reporting)

1,400 / 2,000



Accreditation Check

Only accredited investors (\$1M+ net worth or \$200K+ annual income)

Accredited?
✓ PASS

Lockup Periods

Tokens locked for X months after issuance (vesting)



Forced Transfer

Issuer can forcibly transfer tokens (court order, regulatory action, lost keys recovery)



restrictions exist in traditional securities too – tokenization makes them programmable and automatic rather than manual and error-prone

Exchange Landscape

- **tZERO (US)**: Overstock-backed, SEC-registered ATS. Trades tokenized equity, real estate, digital securities
- **Securitize Markets (US)**: SEC-registered broker-dealer and ATS. Largest platform by issuances (500+). End-to-end: issuance + compliance + trading
- **INX (Israel/US)**: SEC-registered security token exchange. First SEC-registered IPO on blockchain
- **SIX Digital Exchange (Switzerland)**: FINMA-regulated. First fully regulated digital asset exchange by traditional exchange operator
- **Archax (UK)**: FCA-regulated. Focused on institutional investors

Traditional Exchange

T+2 settlement
Limited hours
(9:30–4:00 ET)
Minimum \$25K+
(often)
Paper-based
cap table
Multiple
intermediaries

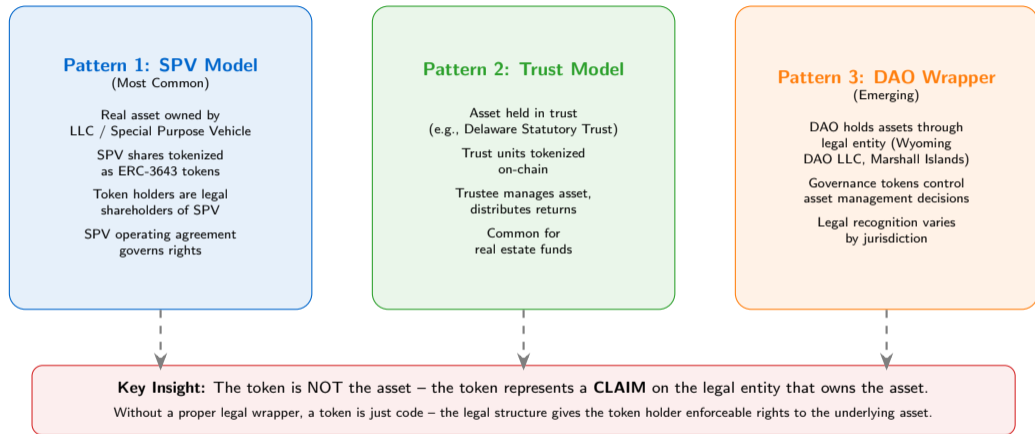
Evolution

Security Token Exchange

T+0 settlement
(instant)
24/7 trading
(potentially)
\$50+ minimums
On-chain
cap table
Smart contract
settlement

security token exchange landscape is still early – combined daily volume across all STO exchanges is tiny compared to traditional exchanges

Legal Wrappers for Tokenized Assets



a proper legal wrapper, a token is just code – the legal structure is what gives the token holder enforceable rights to the underlying asset

Tokenized vs Traditional Securities

Dimension	Traditional Securities	Tokenized Securities
Settlement Time	T+2 days	T+0 (instant on-chain)
Trading Hours	9:30–4:00 M–F	24/7 (potentially)
Minimum Investment	Often \$10K+	\$50+
Custody	Custodian bank required	Self-custody or institutional wallet
Dividend Distribution	Wire transfer (5–10 business days)	Smart contract (instant)
Cap Table	Paper / spreadsheet	On-chain (real-time, auditable)
Compliance	Manual (lawyers, transfer agents)	Automated (ERC-3643)
Cross-Border Access	Complex (different depositories)	Native (blockchain is global)
Issuance Cost	\$500K–\$5M	\$50K–\$500K
Secondary Liquidity	Established exchanges	Early-stage exchanges
Investor Eligibility	Accredited + retail (post-IPO)	Mostly accredited (for now)
Regulatory Status	Well-established	Evolving

Bottom Line: Tokenized securities are NOT yet strictly better – regulatory friction, liquidity depth, and institutional trust still favor traditional markets for most investors today

securities are NOT yet strictly better – regulatory friction, liquidity, and institutional trust still favor traditional markets for most investors

Section 3 Summary: Security Tokens & Compliance

1. The Howey test determines if a token is a security: investment of money + common enterprise + profit expectation + from others' efforts

2. SEC enforces through litigation – the Ripple ruling created nuance (programmatic vs institutional sales)

3. ERC-3643 adds identity verification and transfer restrictions to ERC-20, enabling on-chain regulatory compliance

4. Legal wrappers (SPVs, trusts, DAO LLCs) bridge the gap between on-chain tokens and off-chain legal rights

5. Regulated security token exchanges exist (tZERO, Securitize) but volumes remain tiny compared to traditional markets

3 complete — Next: Section 4 – Tokenized Treasuries & Institutional DeFi

Section

Section 4: Real Estate & Bond Tokenization

Platforms, institutional adoption, yield-bearing tokens, and real-world case studies

What You Will Learn

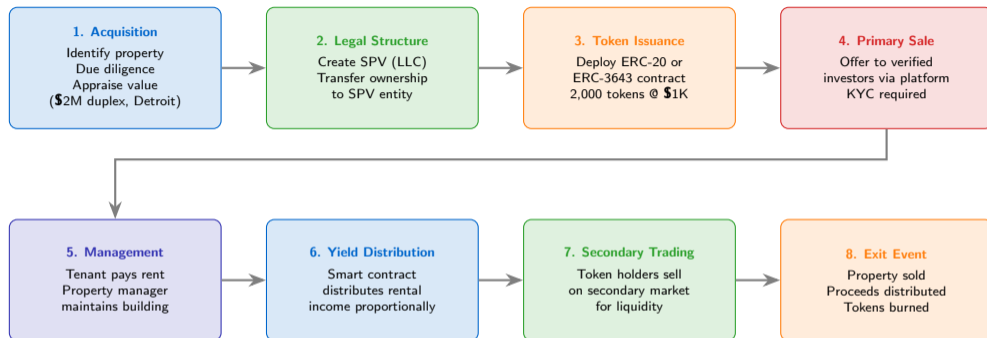
- Real estate tokenization mechanics and platforms (RealT, Centrifuge)
- Bond tokenization by institutions (JPMorgan, Siemens, EIB)
- Private credit markets on-chain (Maple Finance, Goldfinch)
- Yield-bearing tokens: tokenized T-bills and institutional products

Frames in This Section

- Frame 38: Real Estate Tokenization Architecture
- Frame 39: RealT Platform Deep Dive
- Frame 40: Centrifuge Protocol
- Frame 41: Maple Finance & On-Chain Credit
- Frame 42: Bond Tokenization Case Studies
- Frame 43: Yield-Bearing Token Contract (Code)
- Frame 44: Yield-Bearing Token Landscape
- Frame 45: Institutional Adoption Drivers
- Frame 46: Private Credit On-Chain
- Frame 47: Section 4 Summary

4 covers real estate, bonds, private credit, and yield-bearing tokens – the fastest-growing RWA categories

Real Estate Tokenization Architecture



The legal structure ensures token = legal ownership share via SPV

Real estate tokenization combines PropTech, DeFi, and securities law – each step requires expertise in legal, technical, and regulatory domains

RealT Overview

- Pioneer in real estate tokenization (launched 2019)
- Properties: US residential (Detroit, Chicago, Cleveland)
- Blockchain: Gnosis Chain (low fees, fast transactions)
- Token standard: ERC-20 (each property = separate token)
- Minimum investment: ~\$50 per token
- Rental yield: distributed weekly in USDC via smart contract
- Average yield: 8–12% APY (rental income)
- Portfolio: 500+ properties tokenized
- DeFi integration: RealT tokens as collateral on RMM (RealT Money Market)

RealT Property Card

Address: 123 Main St, Detroit MI

Property Value: \$60,000

Token Price: \$50/token

Total Tokens: 1,200

Weekly Rent: \$150 (proportional)

Annual Yield: ~10% APY

Occupancy: 95%

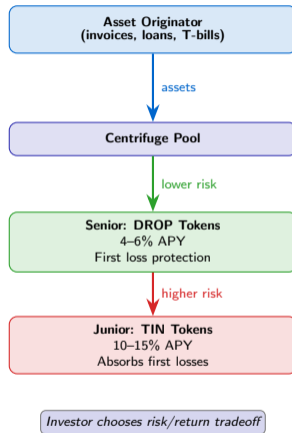
Last NAV Update: 2024-Q4

Weekly USDC distribution to all token holders

is the largest tokenized real estate platform by number of properties – 500+ US residential properties available to global investors for \$50+

Centrifuge Architecture

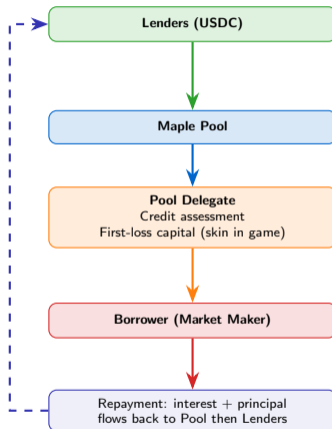
- Tokenizes real-world credit (not just real estate):
 - Trade finance invoices
 - Revenue-based financing
 - US Treasury bills
 - Mortgage-backed loans
 - Warehouse credit lines
- Centrifuge Chain: Substrate-based (bridges to Ethereum)
- Pool structure: Senior + Junior tranches
- Tinlake: DeFi lending protocol for Centrifuge assets
- MakerDAO integration: \$200M+ RWA collateral
- TVL: \$300M+



pioneered structured credit on-chain – tranching allows different risk appetites, exactly like traditional asset-backed securities

Maple Finance

- Institutional undercollateralized lending on-chain
- Pool delegates (credit experts) assess borrower creditworthiness
- Borrowers: crypto market makers, trading firms, fintech companies
- Lending: USDC or wETH, fixed-term loans
- History: launched 2021, \$2B+ total lending volume
- Post-2022 crisis: bad debts from Alameda Research, Orthogonal Trading defaults
- Recovery: pivoted to institutional-grade underwriting, over-collateralized pools
- Maple Direct: compliant lending to institutions



2022 defaults (\$50M+) showed that undercollateralized on-chain lending carries real credit risk – just like traditional banking

JPMorgan Onyx

Tokenized repo transactions (**\$1B+** daily volume)
Intraday settlement (vs overnight traditional)
JPM Coin for instant payment settlement
Onyx Digital Assets: tokenized T-bills, money market funds

Siemens Digital Bond

\$64M bond issued on Polygon (June 2023)
1-year maturity, registered under German electronic securities law
First major corporate bond on public blockchain

European Investment Bank

EUR 100M bond on Ethereum (2021, first)
EUR 50M on Project Venus with BIS (2023)
Partners: BNP Paribas, Goldman Sachs, Societe Generale

World Bank (Bond-i)

AUD 110M bond on Ethereum (2018)
First blockchain bond by multilateral development bank
Managed by Commonwealth Bank of Australia

Bond tokenization is the fastest-growing institutional RWA category

tokenization savings come from instant settlement, 24/7 operations, and automated coupon payments

Yield-Bearing Token (Tokenized T-Bill)

```
1 // Simplified Yield-Bearing Token
2 contract TokenizedTBill {
3     string public name =
4         "Tokenized US T-Bill";
5     uint256 public totalShares;
6     uint256 public totalAssets;
7
8     mapping(address => uint256)
9         public shares;
10
11     function deposit(
12         uint256 usdcAmount
13     ) external {
14         uint256 newShares =
15             totalAssets == 0
16             ? usdcAmount
17             : usdcAmount
18               * totalShares
19               / totalAssets;
20         shares[msg.sender] += newShares;
21         totalShares += newShares;
22         totalAssets += usdcAmount;
23         // Transfer USDC from user
24     }
25
26     function rebase(
27         uint256 yieldAmount
28     ) external onlyManager {
29         totalAssets += yieldAmount;
30         // Share price increases
31     }
32 }
```

Rebasing Vault Pattern (ERC-4626)

- Vault holds underlying assets (T-bills via custodian)
- Users deposit USDC, receive **shares**
- Share price = $\text{totalAssets} / \text{totalShares}$
- Manager calls `rebase()` as T-bills earn interest
- `totalAssets` increases \Rightarrow share price rises
- No token transfer needed – value accrues automatically

Real-World Examples

- **Ondo USDY**: 5.2% APY (T-bills + bank deposits)
- **Franklin BENJI**: 5.0% APY (US Gov Money Fund)
- **MakerDAO sDAI**: 5–8% APY (variable, DSR)
- All use variants of this rebasing/vault pattern

Yield-Bearing Token Landscape

Ondo USDY

Tokenized T-bills
+ bank deposits

\$300M+ AUM
5.2% APY

Ethereum, Solana,
Mantle

Min **\$500**
Accredited only

Franklin BENJI

US Gov Money Fund
(OnChain)

\$400M+ AUM
5.0% APY

Stellar, Polygon

Institutional
First US-registered
fund on public chain

BlackRock BUIDL

USD Institutional
Digital Liquidity Fund

\$500M+ AUM
~5% APY

Ethereum

\$5M minimum
Institutional only

MakerDAO sDAI

DAI Savings Rate

\$2B+ deposits
5-8% APY (variable)

Ethereum

No minimum
Permissionless

Mountain USDM

Yield-bearing
stablecoin

\$200M+
~5% APY

Ethereum

Permissionless

\$2B+ in tokenized treasuries alone (excluding sDAI)

bearing tokens brought the "risk-free rate" on-chain – DeFi users can now earn Treasury yields without leaving the blockchain ecosystem

Yield

Institutional Adoption Drivers

Efficiency

T+0 settlement
vs T+2 traditional

Saves **\$7B+** annually
in collateral costs

24/7 operations
(no market close)

Automated coupon/
dividend payments
via smart contract

Transparency

Real-time on-chain
audit trail

Automated compliance
reporting

Instant cap table
visibility

Verifiable reserves
and holdings

Access

Fractional ownership
enables new investors

Global distribution
without local custodians

Lower issuance costs
(**\$50K** vs **\$500K+**)

Democratized alternatives

Programmability

Programmable compliance
(ERC-3643)

Automated corporate
actions (dividends,
splits, buybacks)

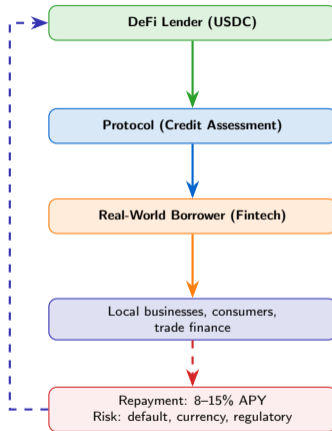
Composability with DeFi
(collateral, lending)

Goldman Sachs estimates tokenization could save \$7B+ in annual collateral costs

The institutional case for tokenization is fundamentally about efficiency – Goldman Sachs estimates tokenization could save **\$7B+** in annual collateral costs

On-Chain Credit Protocols

- **Goldfinch**: emerging market lending (India, Kenya, SE Asia), \$100M+ originated, borrowers are fintech companies
- **Credix**: Latin American credit markets, trade finance and consumer lending
- **Clearpool**: institutional permissioned lending pools
- **TrueFi**: uncollateralized lending to vetted institutions
- Total on-chain private credit: \$500M+ active, \$4B+ cumulative
- Default rates: historically 2–5% (similar to traditional private credit)



chain private credit brings DeFi yields to real-economy lending – but carries real credit risk, as 2022 defaults demonstrated

On-

Section 4 Summary: Real Estate & Bond Tokenization

1. Real estate tokenization (RealT, 500+ properties) enables **\$50** minimum investments with weekly rental yield distribution

2. Centrifuge and Maple Finance bring structured credit on-chain with tranche-based risk/return profiles

3. Major institutions are active: JPMorgan (**\$1B+** daily repo), Siemens (**\$64M** bond on Polygon), EIB (EUR 100M on Ethereum)

4. Yield-bearing tokens (BUIDL, USDY, BENJI) brought the risk-free rate on-chain, attracting **\$2B+** in tokenized treasuries

5. Institutional adoption is driven by efficiency (T+0 settlement), transparency (on-chain audit), and programmability (automated compliance)

4 complete — Next: Section 5 – RWA Ecosystem & Future

Section

Section 5: RWA Ecosystem & Future

Market projections, regulatory landscape, interoperability, and the future of tokenized finance

What You Will Learn

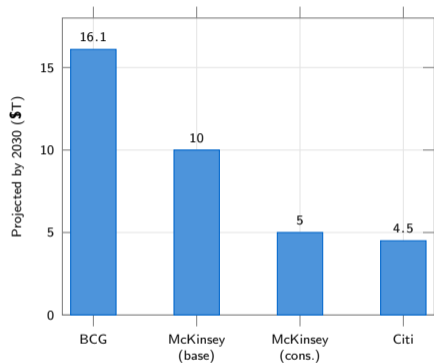
- RWA market size projections (\$10–16T by 2030)
- BlackRock BUIDL and Ondo Finance as category leaders
- MakerDAO's RWA pivot and DeFi-TradFi convergence
- Regulatory challenges and the path to mainstream adoption

Frames in This Section

- Frame 49: RWA Market Size Projections
- Frame 50: BlackRock BUIDL Fund
- Frame 51: Ondo Finance
- Frame 52: MakerDAO's RWA Pivot
- Frame 53: Regulatory Challenges
- Frame 54: TradFi-DeFi Convergence
- Frame 55: Key Takeaways and Course Summary

5 covers the RWA ecosystem, major players, market projections, and the path forward for tokenized finance

Section



Current (2024/2025): ~\$5B tokenized (excl. stablecoins)
Growth multiple: 1,000–3,000x in 5–6 years

Breakdown by Asset Class (2030 Projected)

- Tokenized funds & bonds: \$5T (40%)
- Tokenized real estate: \$3T (25%)
- Tokenized trade finance: \$2T (15%)
- Tokenized securities: \$1T (8%)
- Other (art, IP, carbon, commodities): \$1.5T (12%)

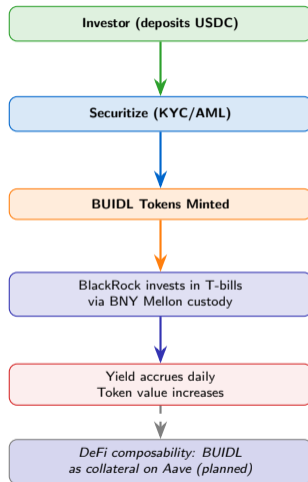
Total addressable:
\$10–16T tokenized by 2030
(from ~\$5B today)

conservative estimates project 1000x growth – the question is not if tokenization will happen, but how fast regulation and infrastructure enable it

Even

BUIDL Details

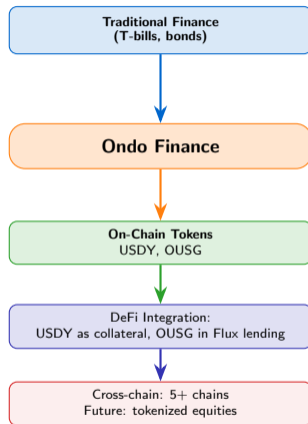
- **Product:** BlackRock USD Institutional Digital Liquidity Fund
- **Asset:** Short-term US Treasury bills
- **Blockchain:** Ethereum (primary), expanding to Avalanche, Polygon, Optimism, Arbitrum via Securitize
- **AUM:** \$500M+ (largest tokenized fund)
- **Minimum:** \$5M (institutional)
- **Yield:** ~5% APY (passes through T-bill yield)
- **Token:** daily NAV rebase, instant transfers
- **Partners:** Securitize (platform), BNY Mellon (custody), PwC (audit)
- **Significance:** BlackRock = \$10T AUM, world's largest asset manager



the world's largest asset manager (\$10T AUM) launches a tokenized fund on Ethereum, it signals institutional conviction that blockchain is the future of finance

Ondo Products

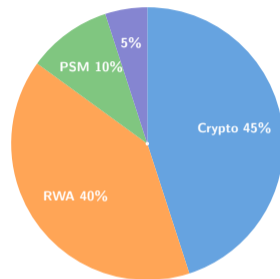
- **USDY**: yield-bearing stablecoin backed by T-bills and bank deposits, 5.2% APY, \$300M+
- **OUSG**: tokenized short-term US government bonds
- Multi-chain: Ethereum, Solana, Mantle, Sui, Aptos
- **Ondo Global Markets**: planned tokenized equities and ETFs
- **Flux Finance**: DeFi lending protocol for tokenized treasuries
- Investment: backed by Pantera, Coinbase Ventures, Founders Fund
- Regulatory approach: Reg D/Reg S exemptions, KYC required



is the bridge between TradFi yield and DeFi composability – its multi-chain approach makes Treasury yields accessible across the crypto ecosystem

MakerDAO (now Sky) RWA Journey

- **2020:** First RWA collateral (Centrifuge assets)
- **2022:** \$500M allocated to US Treasuries (via Monetalis Clydesdale)
- **2023:** RWA allocation reaches \$2B+ (largest DeFi-to-TradFi bridge)
- **2024:** RWA represents 40%+ of DAI backing
- Collateral types:
 - US Treasury bills (\$1.5B+ via BlockTower, Monetalis)
 - Centrifuge pools (trade finance, real estate)
 - Coinbase USDC institutional custody
- Revenue: RWA vaults generate 60%+ of MakerDAO revenue
- Controversy: centralization concerns – DAI now depends heavily on TradFi assets



DAI Backing Composition

Legend:

- Crypto (ETH, WBTC, stETH): 45%
- RWA / US Treasuries: 40%
- PSM (USDC 1:1): 10%
- Other: 5%

RWA pivot is the most significant DeFi-TradFi convergence event – \$2B+ in Treasury bills backing a decentralized stablecoin

Jurisdictional Fragmentation

Token issued in Singapore, traded in EU, held by US investor – which law applies?

No global standard for tokenized securities
MiCA (EU) vs SEC (US) vs MAS (Singapore)
vs VARA (Dubai) – all different rules

Legal Enforceability

Does a token convey LEGAL ownership?
Only if legal wrapper is properly structured

Bankruptcy: are token holders secured creditors?

Smart contract bugs: who is liable?

Cross-Border Settlement

KYC/AML standards differ by country
Tax withholding on cross-border dividends
Currency conversion and FX risk
for international investors

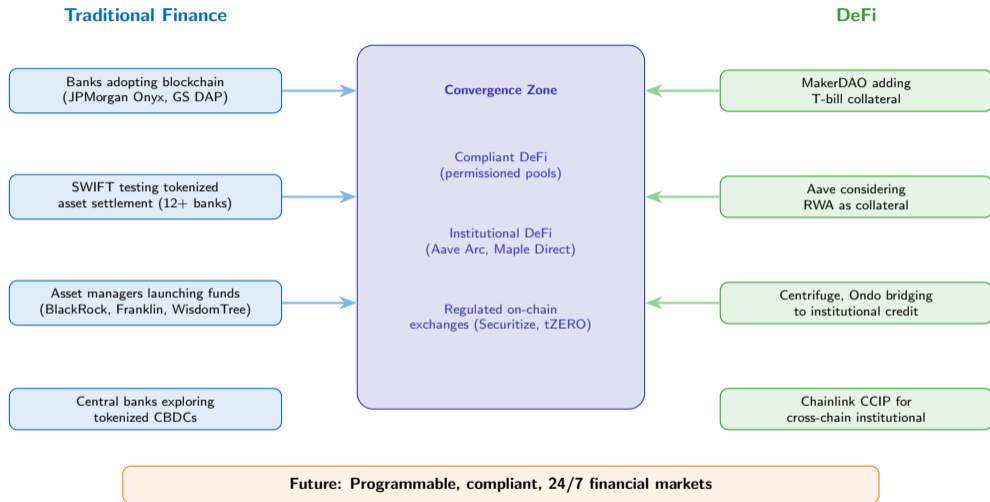
The Oracle Problem (Revisited)

Physical asset can deteriorate or change
status without blockchain update

Who ensures the building hasn't burned down?

Insurance, auditing, dispute resolution
remain off-chain

Regulation is the biggest barrier to RWA growth – technology is ready, legal frameworks are not, and fragmentation across jurisdictions creates friction



convergence is bidirectional: TradFi is coming to blockchain AND DeFi is becoming regulated – the middle ground is “institutional DeFi”

Key Takeaways and Course Summary

1. **Tokenization Fundamentals** – tokenization digitizes asset ownership via blockchain + legal wrappers; ERC-3643 enables compliant security tokens

2. **Stablecoins** – \$150B+ market, fiat-backed dominates; Terra/Luna proved algorithmic models are fatally flawed; MiCA sets regulatory template

3. **Security Tokens & Compliance** – Howey test determines classification; on-chain KYC/AML via identity registries; SPVs bridge legal and digital worlds

4. **Real Estate & Bonds** – RealT (500+ properties), JPMorgan (\$1B+ daily), BlackRock BUIDL (\$500M+); yield-bearing tokens bring risk-free rate on-chain

5. **RWA Future** – \$10–16T projected by 2030; TradFi and DeFi converging; regulation is the biggest barrier; institutional conviction is accelerating

Next: Advanced topics in DeFi-TradFi integration, CBDC design, and cross-chain institutional infrastructure

complete — 5 sections, 55 frames — From tokenization fundamentals to the future of real-world assets on-chain