Blockchain Economics and Digital Assets

Lecture 6: Digital Ownership and Tokenization

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Contents

Overview

Previous lectures focused on blockchain as infrastructure for payments, programmable contracts, and stable-value tokens. This lecture examines a different application: representing *ownership* of assets as tokens on a blockchain.

Tokenization is the process of representing rights to an asset—digital art, real estate, securities, credentials—as tokens on a blockchain. The token becomes a verifiable, transferable representation of ownership that can be traded, fractionalized, and programmed.

The 2021 NFT boom brought tokenization to mainstream attention, with digital images selling for millions of dollars. The subsequent crash exposed the speculative excess: wash trading inflated volumes, utility promises proved empty, and most collections lost nearly all value. But beneath the hype, the underlying technology—provable digital ownership—remains valuable.

Today, institutional interest has shifted toward **real-world asset** (RWA) tokenization. BlackRock, Franklin Templeton, and JPMorgan are tokenizing Treasury bills, money market funds, and other traditional assets. This represents a potentially more durable application of the same underlying capability.

This lecture covers the technology (token standards, metadata storage), the NFT market's rise and fall (and lessons learned), real-world asset tokenization, security tokens, and practical applications from credentials to supply chain tracking.

1 What is Tokenization?

1.1 The Core Idea

Tokenization represents ownership of assets as tokens on a blockchain.

What can be tokenized?

- Digital art and collectibles
- Financial securities (stocks, bonds)
- Real estate
- Commodities
- Credentials and identity
- Virtually any asset with defined ownership

Why put ownership on-chain?

- **Programmability**: Automate dividends, royalties, compliance
- **24/7 trading**: No market hours, instant settlement
- **Fractional ownership**: Own 0.01% of a building
- **Transparency**: Verifiable ownership history
- **Global access**: Anyone with a wallet can participate

1.2 Fungible vs Non-Fungible

Fungible tokens are identical and interchangeable. One unit can be swapped for any other unit of the same type without difference. Examples: Bitcoin, ETH, USDC, company shares.

Non-fungible tokens (NFTs) are unique and not interchangeable. Each token has distinct properties or identifiers. Examples: digital art, event tickets, property deeds, credentials.

The key question is *substitutability*: can you swap one for another without caring which specific one you have?

1.3 What Does a Token Actually Contain?

On-chain (stored directly on blockchain):

- Token ID (unique identifier)
- Owner address
- Contract address
- Transfer history

Off-chain (stored elsewhere, linked via URI):

- Image/media file
- Description and attributes
- Additional metadata

Critical point: Most NFTs do not store the actual image on-chain—it is too expensive. They store a *link* to the image. If the server hosting the image goes down, you own a broken link.

1.4 Metadata Storage Options

Storage	Pros	Cons
On-chain	Permanent, decentralised	Very expensive, size limits
IPFS	Decentralised, content-addressed	Needs pinning, can disappear
Centralised server	Cheap, flexible	Single point of failure
Arweave	Permanent, one-time payment	Cost, smaller ecosystem

IPFS (InterPlanetary File System) is decentralised storage where files are addressed by their content hash, not location. The same content always produces the same address, but files only persist if someone "pins" them.

Best practice: Use IPFS or Arweave for important metadata. Many early NFT projects used centralised servers—some images are already lost.

2 Token Standards

2.1 Why Standards Matter

Token standards define how tokens are created, how ownership is tracked, how transfers work, and what functions wallets and marketplaces can expect.

Interoperability is the key benefit. A standard means any wallet or marketplace can interact with any token following that standard, without custom integration.

2.2 ERC-20: Fungible Tokens

The standard for fungible tokens on Ethereum (2015).

Key functions:

- `totalSupply()`: How many tokens exist?
- `balanceOf(address)`: How many does this address own?
- `transfer(to, amount)`: Send tokens to another address
- `approve(spender, amount)`: Allow another contract to spend your tokens

Examples: USDC, USDT, UNI, LINK, most DeFi tokens.

ERC-20 enabled the 2017 ICO boom and DeFi composability—standardised tokens that any protocol could integrate.

2.3 ERC-721: Non-Fungible Tokens

The standard for NFTs on Ethereum (2018).

Key differences from ERC-20:

- Each token has a unique `tokenId`
- `ownerOf(tokenId)`: Who owns this specific token?
- `tokenURI(tokenId)`: Where is this token's metadata?
- Tokens are indivisible—you cannot transfer 0.5 of an NFT

Examples: CryptoPunks, Bored Apes, most digital art NFTs.

Limitation: Each token requires a separate transaction to mint. Creating 10,000 NFTs means 10,000 transactions—expensive.

2.4 ERC-1155: Multi-Token Standard

A more efficient standard supporting both fungible and non-fungible tokens in one contract (2019).

Key advantages:

- Batch transfers: Send multiple token types in one transaction
- Mixed fungibility: Some IDs can be fungible, others unique
- Gas efficient: Significantly cheaper for games and large collections

Use case: Gaming. Token ID 1 might be gold coins (fungible, 1 million exist). Token ID 2 might be health potions (fungible, 10,000 exist). Token ID 3 might be a legendary sword (non-fungible, only 1 exists). All managed in one contract.

2.5 Comparison

	ERC-20	ERC-721	ERC-1155
Fungibility	Fungible	Non-fungible	Both
Divisible	Yes	No	Configurable
Batch transfer	No	No	Yes
Gas efficiency	Medium	Low	High
Use case	Currencies, shares	Art, collectibles	Gaming, mixed

3 The NFT Market: Rise and Fall

3.1 The 2021 Boom

NFT trading volume exploded in 2021–2022, reaching billions of dollars per month. Bored Ape Yacht Club floor prices exceeded $400,000. Beeple sold digital art for $69 million at Christie's.

What drove the boom:

- Crypto bull market creating wealth effect
- Social signalling (profile picture culture)
- Speculation and "greater fool" dynamics
- FOMO and media hype
- Genuine novelty of provable digital ownership

3.2 The 2023 Crash

Trading volume collapsed by over 90%. Most collections lost 90%+ of value. The "blue chip" collections (Bored Apes, CryptoPunks) retained some value; most others became worthless.

What drove the crash:

- Crypto winter reduced speculative capital
- Utility promises (games, metaverse access) did not materialise
- Wash trading exposed—actual volumes were far lower than reported
- Oversupply: Too many collections, not enough genuine collectors
- Royalty enforcement failed—platforms competed by removing creator royalties

3.3 The Wash Trading Problem

Wash trading is buying and selling an asset to yourself (or colluding parties) to create fake trading volume.

Why it happened in NFTs:

- Marketplace rewards (tokens, airdrops) based on volume
- Create appearance of liquidity and demand

- Manipulate "floor price" for collections
- Tax loss harvesting (in some jurisdictions)

Studies estimate 40–80% of NFT volume was wash trading at peak. Detection methods: same wallet on both sides, circular transactions, economically irrational patterns, wallets funded from same source.

3.4 NFT Valuation Challenges

How do you value a unique asset with no cash flows?

Traditional valuation does not apply:

- No dividends → No DCF
- No earnings → No P/E ratio
- Unique items → No exact comparables

What drives NFT prices:

- Rarity of traits (verifiable on-chain)
- Artist/creator reputation
- Collection brand and community
- Historical sales of similar items
- Social signalling value
- Speculation on future demand

Prices are highly subjective and volatile—more art market than financial market.

3.5 Lessons from the Bubble

What went wrong:

- Speculation overwhelmed utility
- "Community" and "roadmap" promises were often empty
- Royalties were not technically enforceable
- Legal status of ownership remained unclear
- Most buyers were speculators, not collectors

What remains valuable:

- The *technology* of provable digital ownership
- Creator royalties as a *concept* (even if enforcement failed)
- On-chain provenance and authenticity verification
- Programmable ownership rights

The infrastructure is useful. The 2021 use case (speculative JPEGs) was not sustainable.

4 Real-World Asset Tokenization

4.1 The Institutional Pivot

As NFT speculation collapsed, institutional interest shifted to tokenizing traditional assets: Treasury bills, money market funds, corporate bonds, real estate.

Key players entering: BlackRock (BUIDL fund), Franklin Templeton (on-chain money market fund), JPMorgan (Onyx platform), Goldman Sachs (Digital Asset Platform).

This represents a more conservative but potentially durable application of tokenization technology.

4.2 Tokenized Treasuries

What it is: US Treasury bills represented as tokens on a blockchain.

How it works:

1. Issuer (e.g., BlackRock) buys T-bills
2. Issues tokens representing shares in the T-bill portfolio
3. Token holders receive yield (distributed on-chain)
4. Tokens can be transferred 24/7

Why it matters:

- DeFi protocols can hold yield-bearing collateral
- 24/7 settlement (vs T+1 for traditional)
- Programmable: Auto-reinvest, use as collateral in smart contracts
- Global access to US government debt

Market size (2024): Approximately $1.5 billion in tokenized treasuries.

4.3 Case Study: BlackRock BUIDL

BUIDL (BlackRock USD Institutional Digital Liquidity Fund) launched March 2024 on Ethereum.

Structure:

- Invests in T-bills, repos, cash
- Each BUIDL token = $1 (stable NAV)
- Daily accrued dividends (paid monthly)
- Tokenised by Securitize

Requirements:

- Qualified purchasers only ($5M+ investable assets)
- $5 million minimum investment
- KYC/AML through Securitize

Significance: The world's largest asset manager tokenizing products on a public blockchain signals institutional legitimacy.

4.4 Why Tokenize Real-World Assets?

	Traditional	Tokenized
Settlement	T+1 or T+2	Near-instant
Trading hours	Market hours	24/7/365
Minimum investment	Often $1,000+	Can be $1
Fractional ownership	Limited	Native
Cross-border	Complex, expensive	Simplified
Transparency	Periodic reports	Real-time on-chain
Programmability	None	Smart contracts

The promise: more efficient capital markets with lower friction, broader access, and automated compliance.

4.5 RWA Tokenization Challenges

Legal and regulatory:

- What does the token legally represent?
- Securities law compliance
- Cross-jurisdictional recognition
- Bankruptcy treatment of token holders

Technical:

- Oracle problem: Who verifies the off-chain asset exists?
- Custody of underlying assets
- Blockchain scalability and costs
- Interoperability between chains

Market structure:

- Liquidity fragmentation across platforms
- Need for qualified custodians
- Integration with existing financial infrastructure

Tokenization does not eliminate counterparty risk—it shifts it to whoever holds and verifies the underlying asset.

5 Security Tokens

5.1 Definition

A security token represents ownership in a regulated security—equity, debt, or investment contract—and is subject to securities law.

Key distinction:

- **Utility token**: Access to a product/service (may not be a security)
- **Security token**: Investment contract, ownership stake (definitely a security)

The Howey Test (US): Is it an "investment of money in a common enterprise with expectation of profits from efforts of others"? If yes, it is a security.

5.2 ICOs and Their Downfall

Initial Coin Offerings (ICOs) raised over $6 billion in 2017 by selling tokens directly to investors, often before products existed.

Problems:

- Most ICO tokens were likely unregistered securities
- Variable-quality whitepapers, no investor protections
- Anyone could participate regardless of sophistication

The SEC cracked down starting with the 2017 DAO Report. Enforcement actions followed: Munchee ($15M returned), Block.one/EOS ($24M settlement), Telegram/TON ($1.2B returned, project cancelled).

Result: The ICO market collapsed. Projects seeking compliant fundraising turned to **Security Token Offerings** (STOs).

5.3 STOs vs ICOs

	ICO (2017)	**STO**
Regulatory status	Often unclear	Registered or exempt
Investor requirements	Anyone	Often accredited only
Disclosure	Whitepaper (variable)	Prospectus/offering memo
Investor protection	Minimal	Securities law applies
Secondary trading	Unregulated exchanges	Licensed platforms

US exemptions for STOs: Reg D (accredited investors), Reg A+ (mini-IPO up to $75M), Reg S (non-US investors).

5.4 Security Token Infrastructure

Issuance platforms (Securitize, Polymath) provide:

- KYC/AML verification of all token holders
- Transfer restrictions (only to verified wallets)
- Compliance with holding periods
- Cap table management
- Reporting and disclosure

Technically: whitelists of approved addresses, transfer functions that check compliance before executing, forced transfers for legal requirements, automated dividend distribution.

This is *permissioned* tokenization—not the "anyone can participate" ethos of DeFi.

5.5 Current State

What has been tokenized: real estate, private company equity, fund shares, corporate bonds, revenue-sharing agreements.

Challenges:

- Limited secondary market liquidity
- High compliance costs relative to deal size
- Fragmented global regulatory landscape
- Chicken-and-egg: need liquidity to attract issuers, need issuers to build liquidity

Security tokens are growing but remain niche. Institutional adoption (BlackRock, etc.) may catalyse broader growth.

6 Practical Applications

6.1 Digital Art and Collectibles

Despite the crash, the core use case—provable digital ownership for art—remains valid.

What works: Provenance tracking, direct artist-to-collector sales, global market access.

What does not: Speculation-driven pricing, copyright transfer (usually not included), the "right-click save" criticism (though this misunderstands ownership vs copying).

The sustainable use is authentication and provenance—galleries and auction houses integrating NFTs for verification, not speculative trading.

6.2 Supply Chain and Provenance

Track products from origin to consumer using tokens as identifiers.

Examples: Food traceability (Walmart + IBM Food Trust), pharmaceutical supply chain, conflict mineral tracking, luxury goods authentication (LVMH's Aura).

How it works: Each product gets a unique token/identifier; each handoff is recorded on-chain; consumers can verify full history.

Limitation: The oracle problem again. Blockchain cannot verify that the physical item matches the digital record. "Garbage in, garbage out"—immutably recorded.

6.3 Credentials and Soulbound Tokens

Soulbound tokens (SBTs) are non-transferable tokens representing credentials, affiliations, or reputation.

Examples: University degrees, professional certifications, proof of attendance, reputation scores.

Unlike NFTs, SBTs cannot be sold or transferred—they are "bound" to the recipient's wallet, representing earned or verified attributes rather than tradeable assets.

Challenges: Privacy (credentials visible on public blockchain), recovery (what if you lose wallet access?), adoption (issuers must participate).

6.4 Fractional Ownership

Tokenize expensive assets and sell fractions.

Examples: Real estate (own 0.1% of a building), art (shares in a Picasso), collectibles (fractional sports memorabilia).

Benefits: Lower minimum investment, diversification, liquidity for illiquid assets.

Challenges: Securities law (usually applies), governance (who decides to sell the underlying?), custody and insurance, thin secondary markets.

Reality: Fractionalization existed pre-blockchain (REITs, art funds). Tokenization adds programmability and potentially broader access, but regulatory complexity remains.

7 Challenges and Future

7.1 The Oracle Problem (Again)

Blockchain can only verify on-chain data. For tokenized real-world assets, someone must verify: Does the asset exist? Is it authentic? Who owns it legally?

This gap between physical and digital worlds requires trusted intermediaries—auditors, custodians, legal systems. Tokenization does not eliminate trust; it shifts it.

7.2 Legal Status

Key unresolved questions:

- Does the token holder have legal title to the underlying?
- What happens in bankruptcy?
- Which jurisdiction's law applies?
- How are disputes resolved?

Current approaches: Token represents contractual claim (not direct ownership), SPV structures (token = shares in entity owning asset), legal wrappers with token as "digital twin."

Regulatory developments: MiCA (EU framework), UK Law Commission (recognising digital assets as property), Wyoming (DAO and digital asset laws).

7.3 The Future

Near-term (2–5 years):

- Tokenized treasuries and money market funds scale
- More traditional asset managers enter
- Regulatory clarity improves
- Security token infrastructure matures

Medium-term (5–10 years):

- Broader asset classes tokenized (private equity, real estate)
- Integration with traditional financial infrastructure
- CBDCs potentially interoperating with tokenized assets
- Credentials and identity (SBTs) gain adoption

Key question: Will tokenization happen on public blockchains (Ethereum) or private/permissioned systems? The answer affects decentralisation, access, and composability.

8 Summary and Looking Ahead

This lecture has covered digital ownership and tokenization. Key takeaways:

Tokenization represents ownership as blockchain tokens. Fungible (ERC-20) for interchangeable assets, non-fungible (ERC-721) for unique items, multi-token (ERC-1155) for mixed use cases.

NFT speculation crashed, but the technology remains. Wash trading, hype, and unsustainable economics drove the bubble; provable digital ownership remains valuable.

Real-world asset tokenization is growing. BlackRock, Franklin Templeton, and others are tokenizing treasuries and funds, bringing institutional credibility.

Security tokens require compliance. STOs differ from ICOs in regulatory status, investor requirements, and secondary market restrictions.

Practical applications extend beyond speculation. Credentials, supply chain, fractional ownership—though all face the oracle problem.

Challenges remain. Legal status of tokens, physical-digital bridge, interoperability, and liquidity fragmentation.

In the next lecture, we turn to cryptocurrency investment—market structure, valuation approaches, risk factors, and the emergence of regulated investment products like ETFs.

Readings

Required:

- Chalmers, D., Fisch, C., Matthews, R., Quinn, W., & Sherrill, J. (2022). "Beyond the Bubble: Will NFTs and Digital Proof of Ownership Empower Creative Industry Entrepreneurs?" *Journal of Business Venturing Insights*, 17, e00309.

Supplementary:

- Nadini, M., et al. (2021). "Mapping the NFT Revolution: Market Trends, Trade Networks, and Visual Features." *Scientific Reports*, 11, 20902.
- World Economic Forum. (2024). "Tokenization of Real-World Assets: A Path to More Efficient Capital Markets."
- Weyl, E. G., Ohlhaver, P., & Buterin, V. (2022). "Decentralized Society: Finding Web3's Soul." On soulbound tokens.