

Lesson 20: Tokens – ERC-20 and NFTs

Module 2: Blockchain Fundamentals

Digital Finance

What is a Token?

Definition:

- Digital asset on blockchain
- Smart contract manages ownership
- Not native currency (e.g., not ETH)
- Programmable properties

Types:

- **Fungible:** Interchangeable (e.g., USDC, UNI)
- **Non-Fungible:** Unique (e.g., NFTs, real estate)
- **Semi-Fungible:** Hybrid (e.g., gaming items)

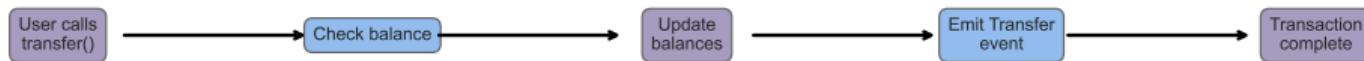
charts/lesson_20/token_types.pdf

[charts/lesson_20/erc20_overview.pdf](#)

ERC-20 Implementation Example

`charts/lesson_20/erc20_code_structure.pdf`

ERC-20 Token Transfer Flow



Direct Transfer:

- ① User calls `transfer(recipient, 100)`
- ② Contract checks balance
- ③ Contract deducts 100 tokens from sender
- ④ Contract adds 100 tokens to recipient
- ⑤ Contract emits `Transfer` event
- ⑥ Transaction complete

Approval and TransferFrom Pattern

Use Case:

- Allow smart contract to spend your tokens
- Required for DeFi (DEXs, lending)
- Two-step process

Steps:

- ① User approves DEX: `approve(DEX, 1000)`
- ② DEX calls: `transferFrom(user, pool, 500)`
- ③ Check allowance, transfer tokens

charts/lesson_20/approve_transferfrom.pdf

Popular ERC-20 Tokens (2024)

Token	Symbol	Market Cap	Use Case
Tether	USDT	\$100B+	Stablecoin (pegged to USD)
USD Coin	USDC	\$30B+	Regulated stablecoin
Uniswap	UNI	\$5B+	DEX governance token
Chainlink	LINK	\$8B+	Oracle network payments
Wrapped Bitcoin	WBTC	\$10B+	Bitcoin on Ethereum

Total ERC-20 Tokens: >500,000 deployed on Ethereum

Token Utility: Why Create Tokens?

Governance:

- DAO voting rights (e.g., UNI, COMP)
- Protocol parameter changes
- Treasury allocation

Access:

- Platform access (e.g., Filecoin storage)
- Fee discounts (e.g., BNB on Binance)
- Staking for rewards

Incentives:

- Liquidity mining rewards
- Early adopter benefits
- Network effects

Speculation:

- Investment asset
- Price appreciation
- Trading on exchanges

charts/lesson_20/nft_concept.pdf

Required Functions:

- `balanceOf(owner)`: Number of NFTs owned
- `ownerOf(tokenId)`: Who owns specific token
- `transferFrom(from, to, tokenId)`: Transfer NFT
- `approve(to, tokenId)`: Approve transfer
- `safeTransferFrom(...)`: Safe transfer (checks recipient can receive)

Optional Metadata Extension:

- `tokenURI(tokenId)`: Returns URL to metadata JSON
- Metadata typically stored on IPFS or centralized server

Example: CryptoPunks, Bored Ape Yacht Club, Azuki

NFT Metadata Structure

On-Chain (Contract):

- Token ID
- Owner address
- Approval state
- Pointer to metadata URI

Off-Chain (IPFS/Server):

- Name, description
- Image/video URL
- Attributes (rarity traits)
- Properties

charts/lesson_20/nft_metadata_flow.pdf

Digital Art:

- Provable ownership
- Royalties on resales (via marketplaces)
- Scarcity enforcement

Gaming:

- In-game items (weapons, skins)
- Land ownership (Decentraland)
- Cross-game interoperability

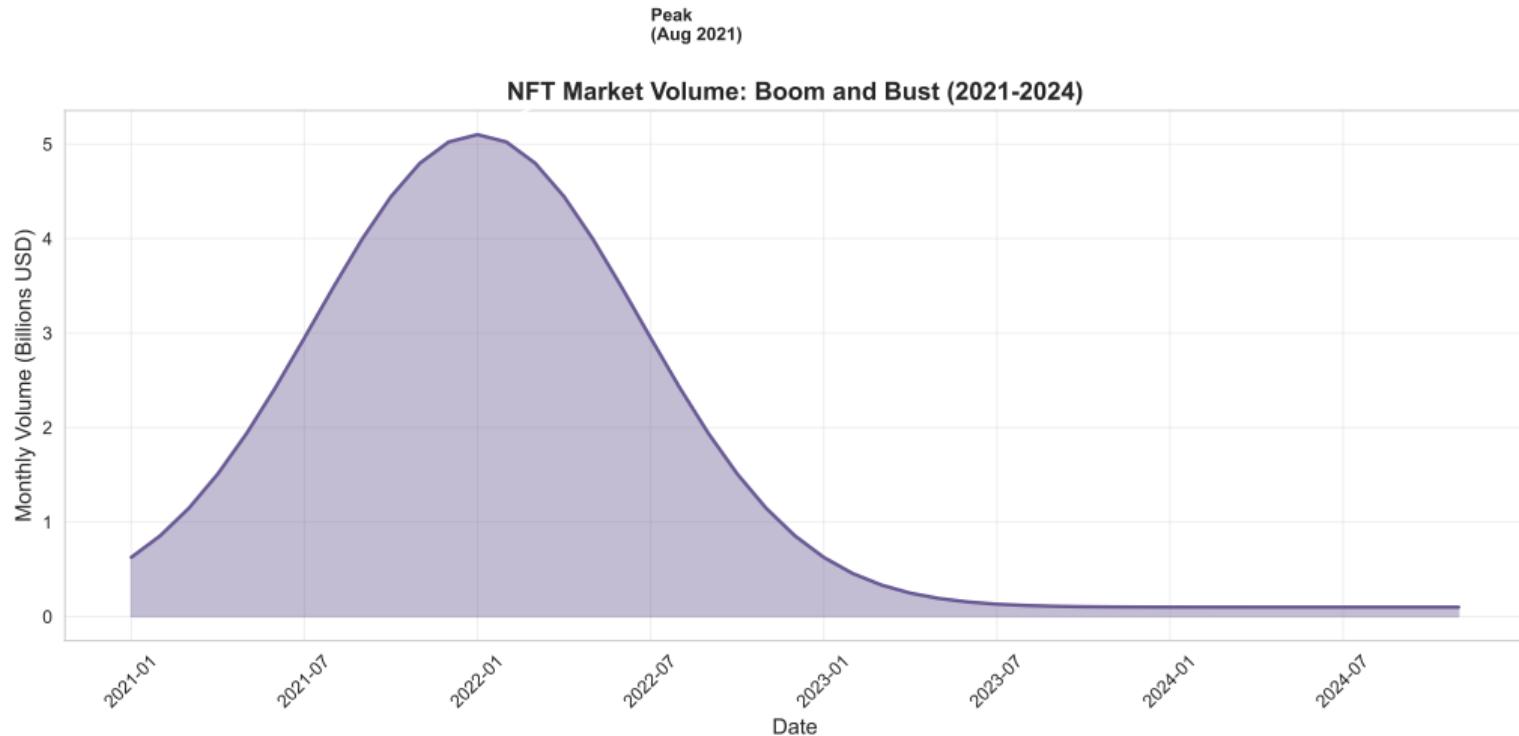
Identity/Credentials:

- Digital diplomas
- Membership badges
- Soulbound tokens (non-transferable)

Real-World Assets:

- Real estate deeds
- Luxury goods authentication
- Tickets/event access

NFT Mania: 2021 Boom and Bust



Peak (Aug 2021 – Jan 2022):

- Monthly volume: \$5B+ on OpenSea
- Bored Ape floor price: 150 ETH (\$600K)
- Celebrity endorsements, mainstream media

- **Ownership Confusion:** You own token, not copyright or image itself
- **Environmental (Pre-Merge):** High energy usage on PoW Ethereum
- **Speculation Bubble:** Most projects have no utility, pure speculation
- **Centralization:** Metadata often on centralized servers, not fully decentralized
- **Money Laundering:** Wash trading, inflated sale prices
- **IP Issues:** Plagiarism, unauthorized minting of others' art
- **Market Manipulation:** Pump-and-dump schemes, insider trading

Counterargument: Technology has legitimate use cases beyond JPEGs (credentials, gaming, ticketing)

Tokenomics: Designing Token Economics

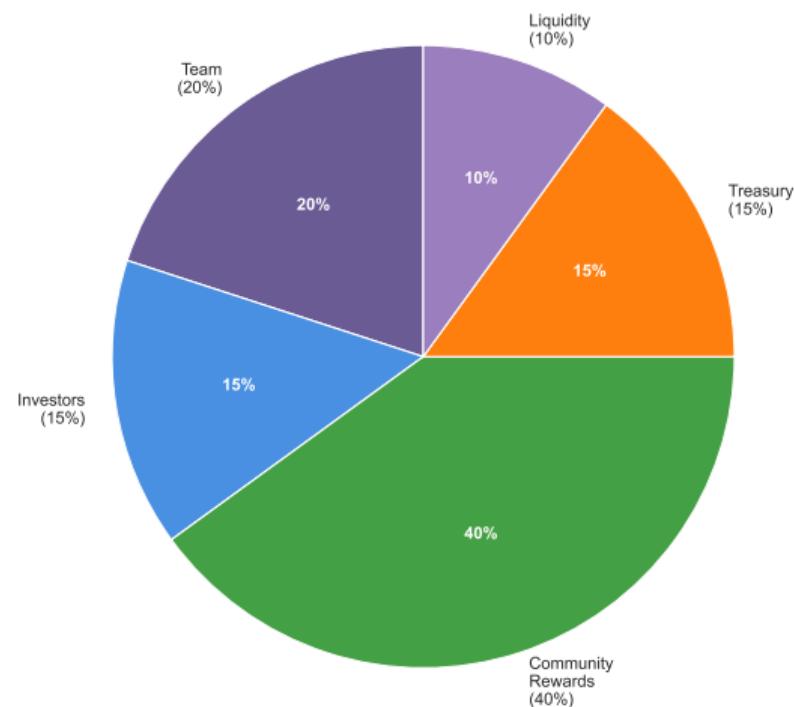
Supply Mechanics:

- **Fixed Supply:** Bitcoin (21M cap)
- **Inflationary:** Continuous issuance (older Ethereum)
- **Deflationary:** Burn mechanisms (EIP-1559)
- **Elastic:** Rebasing (Ampleforth)

Distribution:

- Team allocation (with vesting)
- Investors/VCs (lockup periods)
- Community rewards (airdrops, mining)
- Treasury for governance

Typical Token Distribution (Tokenomics)



Vesting and Lock-Ups

[charts/lesson_20/vesting_schedule.pdf](#)

Airdrops: Free Token Distribution

Reasons:

- Reward early users
- Decentralize governance
- Marketing/awareness
- Avoid securities regulations (gift, not sale)

Famous Examples:

- Uniswap: 400 UNI to all users (**\$1200+**)
- Ethereum Name Service: Retroactive airdrop
- Arbitrum: Governance token to users

[charts/lesson_20/airdrop_strategy.pdf](#)

Model	Mechanism	Pros/Cons
ICO (2017–18)	Public sale at fixed price	Simple, but many scams, regulatory issues
IEO (2019)	Sale on exchange (e.g., Binance Launchpad)	Vetted, but centralized
Fair Launch (2020)	No pre-sale, everyone equal	Community-driven, but vulnerable to bots
LBP (2021)	Liquidity Bootstrapping Pool (declining price)	Price discovery, less FOMO

Trend: Moving away from ICOs toward fairer, community-first models

ERC-1155: Multi-Token Standard

Innovation:

- Single contract manages multiple token types
- Fungible, non-fungible, semi-fungible
- Batch operations (gas efficient)

Use Case: Gaming

- Gold (fungible)
- Sword #123 (non-fungible)
- Health potion (semi-fungible, limited)
- All in one contract

[charts/lesson_20/erc1155_structure.pdf](#)

- **Reentrancy:** External calls before state updates (use checks-effects-interactions)
- **Integer Overflow/Underflow:** Fixed in Solidity 0.8+ (automatic checks)
- **Approval Race Condition:** Approve 0 before changing allowance
- **Unchecked Return Values:** ERC-20 transfer may silently fail
- **Front-Running:** Miners/bots see pending transactions, exploit
- **Centralization:** Owner has mint/burn/pause powers (rug pull risk)

Best Practice: Use OpenZeppelin audited contracts, multiple audits, time-locks on admin functions

- **ERC-20:** Fungible token standard, balances, transfer, approve/transferFrom
- **ERC-721 (NFTs):** Unique tokens, digital art/collectibles/gaming
- **NFT Metadata:** On-chain ownership, off-chain images (IPFS/centralized)
- **Tokenomics:** Supply, distribution, vesting, airdrops
- **ERC-1155:** Multi-token standard, efficient for gaming
- **Security:** Reentrancy, overflows, centralization risks

Next Lesson: DeFi Fundamentals – AMMs, liquidity pools, lending protocols