

## On-Chain / Off-Chain

In the context of blockchain and crypto, **on-chain** vs **off-chain** refers to where data or transactions are recorded and processed.

**On-chain** means something is recorded directly on the blockchain — the permanent, public, decentralized ledger. Every node in the network verifies and stores it. Key traits: transparent, immutable, trustless (no middleman needed), but slower and more expensive (you pay "gas" fees).

**Off-chain** means the activity happens outside the blockchain, often on a separate server, database, or layer-2 network. It's then either summarized/anchored to the chain later, or never recorded on-chain at all. Key traits: faster, cheaper, more flexible, but requires some degree of trust in whoever manages the off-chain system.

A practical example is NFT artwork. The NFT token itself (ownership record) is on-chain, but the actual image file is almost always stored off-chain (e.g., on IPFS or a company's server) because storing large files directly on a blockchain would be prohibitively expensive. If that server goes down, the image is gone — even if you still "own" the token.

Something created **fully on-chain** means all its data — the logic, the visuals, everything — lives entirely within the blockchain. This is considered the gold standard for permanence and decentralization, since there's no external dependency that can disappear. Generative art projects like Art Blocks store their generation code on-chain so the artwork can always be reproduced from the chain alone.

The tradeoff in a nutshell: on-chain = more trustworthy and permanent, but costly and limited in scale. Off-chain = faster and cheaper, but introduces some trust or centralization.