

COTW: Dude, Where's my NFT?

While NFTs are as permanent as the blockchain they reside on, much of an NFT's data is stored off-chain and the manner in which it is stored has profound implications for its permanence. We review the components of an NFT, examine metadata storage options, and provide a brief tutorial on how to look up, view, and assess an NFT's metadata in this week's Chart of the Week.

- **NFT Basics:** Non-fungible tokens (NFTs) are blockchain-based digital assets that are solely unique and therefore not interchangeable. NFTs can represent ownership in unique items of value like digital art, domain names, intellectual property, and event tickets, can be employed in a variety of use cases like collectibles, gaming, media, music, and finance, and in the future, [will usher in new paradigms around content, ownership, value, and exchange](#). That said, the underlying item, currently most commonly artwork, that the NFT represents is rarely stored on the blockchain, given space and cost limitations. Instead, an NFT typically contains a URI pointing to JSON-formatted metadata that includes the underlying item's name, location, creator, and description. This bifurcation of an NFT and its metadata/underlying item is incorporated into Ethereum's most popular NFT token standard, ERC-721, via the optional tokenURI method, which tells applications where to find the metadata for a given token ID. As such, NFTs really tell you where the content lived at the time it was minted, and can alternatively be thought of as a registry that maps assets, identified by a token ID, to its owners, in the form of a wallet address. And, the way this metadata and underlying artwork is stored has profound implications for the NFT itself.
- **NFT Storage Options:** While non-fungible tokens are as permanent as the blockchains they reside on, the persistency of the metadata linked to the NFT depends largely on the storage method used, and varies widely between platforms, artists, and developers. Storage options include:
 - On-Chain Storage: Blockchains make a fantastic distributed ledger, but perform poorly when it comes to storage. As such, while on-chain storage is immutable and easy to access, it can be incredibly expensive, and thus on-chain storage of an NFT and its components is infrequently used. Anonymice, however, is an example of a project that is 100% on-chain.
 - Centralized Storage: Metadata and the underlying item may be stored on a centralized server or via a cloud solution like Amazon S3 or Google Cloud Storage. Centralized methods are affordable, fast, and many are routinely backed up so the risk of accidental loss is low. That said, the files may be taken down, whether the developer goes out of business or forgets to

pay the hosting fees, or may be changed by the developer at any time. When this happens, the actual tokens will still exist but may point to a broken link or to a different artwork, potentially causing the NFT to lose significant value. In fact, there are numerous examples of this happening, as was the case with Tron Dogs and NiftyMoji. While there are partial solutions such as paying for a service to cache metadata, using centralized servers to store NFT metadata and the underlying item ushers in large risks related to persistence and manipulation.

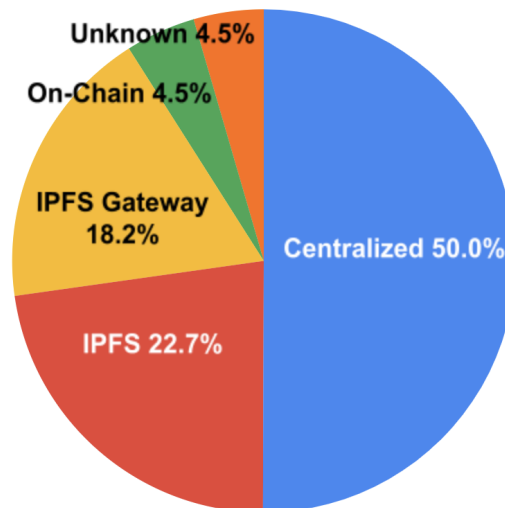
- Decentralized Storage: Using a peer-to-peer file storage system such as IPFS allows for hosting files on multiple computers, reducing dependency on any single one. Moreover, this method uses content addressing, where the address of the data is actually a hash of the data itself, rather than using the location-based address method of the current traditional internet that has the inherent flaws described above. As a hash of the data, this content identifier known as a CID is directly derived from the data itself, and as such, one can be sure that the data has not changed as long as it's being accessed via the same address. One downside of IPFS, however, is that it relies on nodes being willing and able to cache and share resources with the network, which may not always be the case. One can use a pinning service to overcome this, but data can still disappear if one stops paying for the service. Filecoin can be used to incentivize a storage provider to maintain the data, and the owner of the NFT taking care of it is similar to traditional art, where the buyer is responsible to custody and preserve the art once in possession of it. Arweave, which is built specifically for permanent data storage, is gaining momentum with NFTs as a decentralized storage option, as it allows a user to pay once to store data for as long as the network exists, and also has guarantees on data availability and fast data access.

We show data compiled by Matt Lim for 22 top NFT projects in **Exhibit 1** below. Despite the fact that these are top-tier projects, half of them are storing their metadata and underlying artwork on centralized servers, potentially impacting the persistency and permanence of the NFTs themselves.

- **Where's my NFT?:** Using examples from Ethereum, to locate and view your NFT's metadata, which will include the location of the underlying artwork, likely in the form of a URL or IPFS address, find your wallet address in a blockchain explorer like Etherscan and click on the NFT token standards ERC-721 or ERC-1155 to view your NFTs. Note your TokenID and click on the contract, which will be listed under the column labeled Token, to go to the NFT's smart contract. Alternatively, you can find your NFT on OpenSea, and the contract address and TokenID will be listed under the Details section. From the smart contract page in Etherscan, click on contract, then click on read contract. Navigate down to tokenURI, and input your TokenID and hit query. It will return the location of your NFT's metadata, likely in the form of a URL or an IPFS address. Copy and paste the URL into a new tab to view your NFT metadata, which will also show where the underlying artwork is being stored. If the output is an IPFS address, you can view your metadata through an IPFS gateway. Simply insert the returned hash into the following URL as paste into a new tab on your web browser: <https://ipfs.io/ipfs/<your-ipfs-hash>>. To demonstrate, we show the following two examples:

- Centralized Storage - Meebit #9765: Locate the item [on OpenSea](#). Click on Details to see the TokenID of 9765 before clicking on the Contract Address, which takes you to [its smart contract on Etherscan](#). Click on Contract, Read Contract, then scroll down to tokenURI, before entering 9765 and hitting query. It will return [this URL](#), which when entered into a new tab, will display the metadata, including the location of the image, both of which are centrally stored.
- Decentralized Storage - Bored Ape Yacht Club #720: Locate the item [on OpenSea](#). Click on Details to see the TokenID of 720 before clicking on the Contract Address, which takes you to [its smart contract on Etherscan](#). Click on Contract, Read Contract, then scroll down to tokenURI, before entering 720 and hitting query. It will return the following IPFS address `ipfs://QmeSjSinHpPnmXmspMjwiXyN6zS4E9zccariGR3jxcaWtq/720`. Append “`https://ipfs.io/ipfs/`” to the CID above (everything after “`ipfs://`”) to view the metadata via the ipfs.io gateway, as [shown here](#).

Exhibit 1: NFT Metadata Location, Top 22 Projects



Source: Matt Lim via Medium, GSR

Author: Brian Rudick, Senior Strategist

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