



Unlocking the Power of NFTs: Introducing Token Bound Accounts with ERC-6551

Executive Summary

- The ERC-6551 introduces the Token Bound Account (TBA) concept, which provides a dedicated smart contract wallet to every NFT. This wallet is capable of interacting with dApps and managing various types of crypto assets.
- TBAs can be created via a registry contract with the NFT as the owner, and NFT owners authorized to execute on-chain actions using it. This provides transaction records, signature control, and ownership links that are empowered for each NFT. As a result, the increased ownership of assets and transaction history could potentially modify their respective values.
- One of the benefits of ERC-6551 is that it enables NFT composability, which facilitates use cases like game character management and asset management. Additionally, it could spark a usage history of NFTs in terms of DAO loyalty programs, that use NFTs as a binding mechanism, linking all reputation to the NFT itself.
- The TBA could assist in metaverse and digital fashion with avatars holding assets and bonding via NFTs. The display of the avatar is determined by the NFT that it has equipped.

What is ERC-6551?

ERC-6551 proposes a novel standard that enables the creation of smart contract wallets dedicated to each ERC-721 token on the Ethereum blockchain. These smart contract wallets, referred to as Token Bound Accounts (TBA), provide any ERC-721 token with a range of functionalities, including transactional capabilities, interoperability with other applications, holding crypto assets (tokens and *non-fungible tokens (NFTs)*).

The TBAs are implemented and managed through an open registry without permission, which preserves all on-chain activities executed by the smart contract wallets in an immutable fashion. Essentially, ERC-6551 gives NFTs a new level of responsibility and usefulness, making them easier to use, track, and change.

The ERC-6551 is launched by the team at Future Primitive, an on-chain product studio led by a co-founder of CryptoKitties/Dapper Labs and the co-founder of Bitski. They believe that token binding will be a significant technological leap for the NFT ecosystem.

In simple terms, ERC-6551 allows each NFT to have its own smart contract wallet. This means that the NFT can act as an on-chain identity, holding various types of crypto assets. The best part is that it doesn't require any changes to the NFT itself, making it easy to apply to any type of NFT, whether it's ERC-721 or ERC-1155.

Note, ERC-6551 is not considered as a token standard like ERC-20/721. In essence, ERC-6551 is not designed to facilitate the launch of standardized assets, but rather provides a standard for token-bound accounts that are associated with existing NFTs.

Architecture

The architecture of ERC-6551 is composed of two main components:

- A permissionless registry for deploying token bound accounts
- A standard interface for token bound account implementations

Registry

The registry serves as a single entry point for projects wishing to utilize token bound accounts. The registry contract is permissionless, immutable, and has no owner.

Registry contract contains two functions: createAccount and account. The createAccount function deploys a TBA for the NFT while the account function computes the TBA address for a specific NFT. To ensure the TBA addresses are deterministic, the createAccount function uses the create2 method. The latter opcode gives the ability predict the address where a contract will be deployed, without ever having to do so.

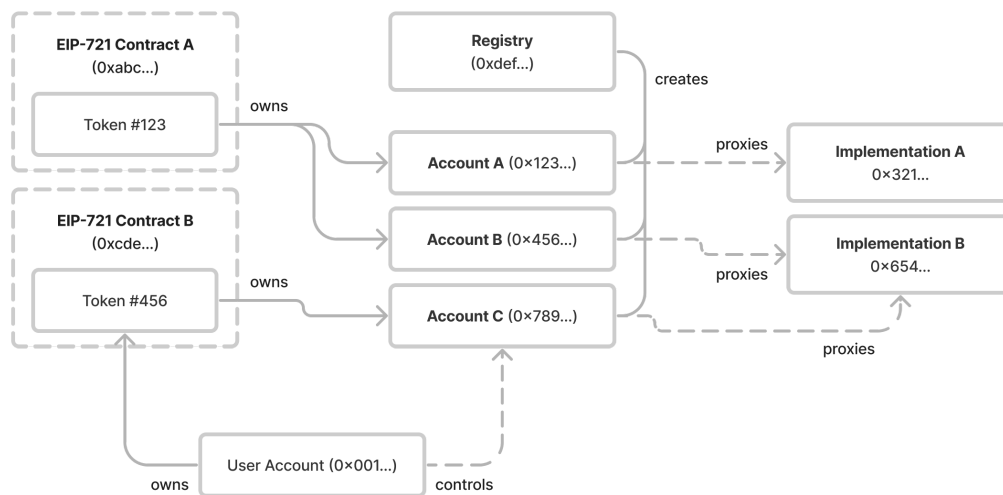
In order to optimize efficiency and reduce expenses, each TBA is deployed as an ERC-1167 minimal proxy contract, which allows for cost-effective deployment and streamlined operations. As such, a single proxy contract can be utilized for multiple TBAs, ultimately decreasing the amount of gas and operational effort required.

Account Interface

It is necessary for all token bound accounts to be established through the registry. TBAs also adhere to Ethereum standards ERC-165 and ERC-1271. ERC-165 makes it easier for users to interact with them while ERC-1271 enables users to sign messages on behalf of smart contracts, enhancing the overall security of TBAs.

Correlation

The diagram below depicts the correlation among ERC-721 tokens, their respective owners, token bound accounts, and the Registry.



Source: [EIP-6551](#)

- An EOA (user) owns the NFT
- The TBA is created via registry contract and NFT has the ownership of its TBA
- The control of TBA is delegated to the owner of that NFT
- The owner, on behalf of the NFT, can initiate on-chain actions using the TBA
- NFT is able to own multiple TBAs, one per implementation address
- The TBA is able to own any crypto assets so it is possible to own the TBA of TBA, i.e., NFT A creates a TBA A and transfer an NFT B to TBA A, then NFT B is able to create TBA B.

Risks

As ERC-6551 is a newly developed standard, it is worth mentioning that it may pose some security risks.

1. Registry safety

Malicious parties may create duplicate registries or implementations for an ERC-721 protocol. It is crucial to consider providing additional insight into the identity of the caller of the createAccount function to enhance security measures.

2. Ownership cycles

In the event of an ownership cycle being created, all assets held in a token bound account may become unreachable. An example of such a scenario is when an ERC-721 token is transferred to its own bound account. In this case, the token and all assets stored in the bound account will become permanently inaccessible because the account is not capable of executing a transaction that transfers the ERC-721 token. This highlights the importance of ensuring secure ownership transfers to prevent such incidents from occurring.

Additionally, if the NFT is burned, the corresponding TBA and all assets it is holding will become permanently inaccessible.

3. Fraud

As the owner of its TBA, the value of related assets held in the TBA becomes a crucial consideration for potential buyers when purchasing an NFT. When a seller has a range of assets held in the TBA associated with the listed NFT, he may transfer the assets in one go during the purchase, resulting in a loss for the buyer. Therefore, it is important for marketplaces to implement strong remedial actions to prevent such cases.

Potential use cases of ERC-6551

1. On-chain game character

Given the unique ability of NFTs to truly own their assets, they have great potential in on-chain games. For example, a character in such a game can own all of its equipments (NFTs), and any battle experiences or history can be recorded directly onto the character's NFT (txns).

All assets obtained from the game can be sent directly to the TBA. This feature enhances the user experience and opens up new possibilities for in-game user interfaces. Previously impossible AI-generated characters can now have their behavior dictated by their history or equipment.

Moreover, when the character is transferred between users, all of these assets and records will move with it seamlessly.

Below is an example of what a character vault could look like in a vault.



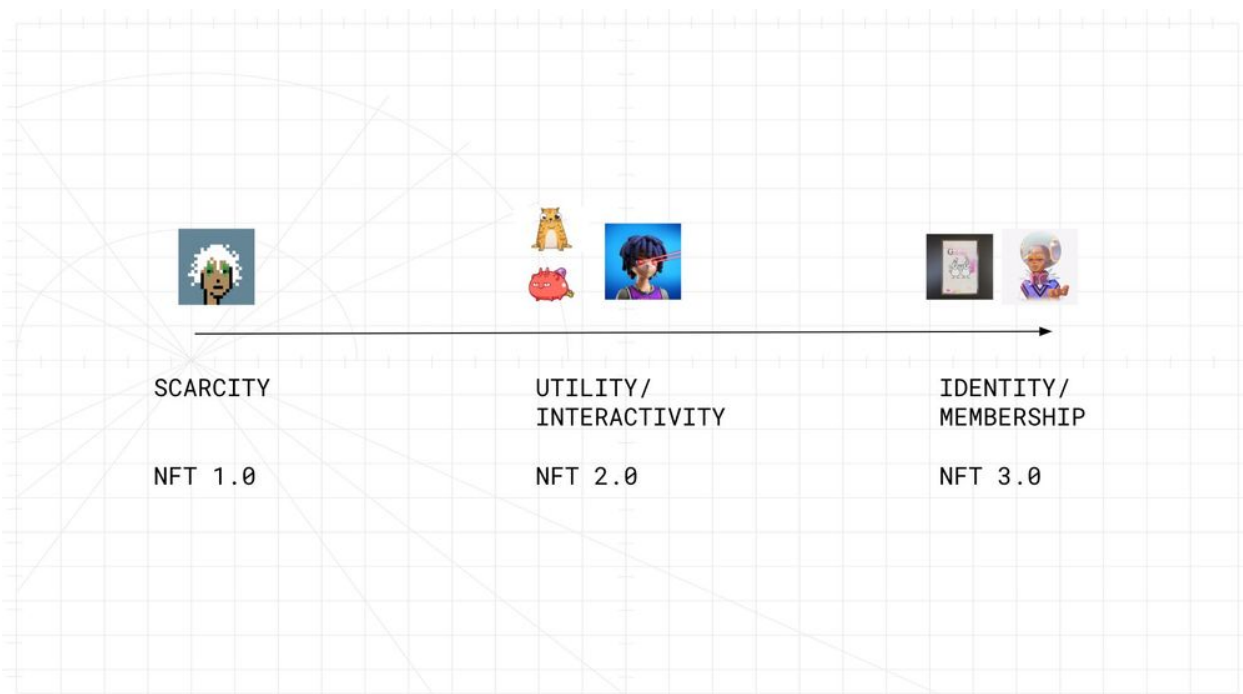
Source: [Benny Giang](#).

2. On-chain identity

Lens protocol has taken an important step towards using NFTs as a form of identity verification, but currently, all related data is stored within personal wallets rather than the NFT itself. ERC-6551 functions as an NFC passport entry that consolidates all transactions and activities. By consolidating decentralized on-chain activities under individual ownership, it simplifies the process of finding all official information associated with an individual's name and promotes transparency.

Sometimes, individuals might want to highlight only certain aspects of their profile instead of presenting a complete and all-encompassing overview of themselves. For example, on a social media platform, someone might choose to prominently display their artistic pursuits and creations instead of sharing information about their job, education, and personal life. In this case, they are showcasing a particular characteristic or talent that they perceive as important or defining, rather than presenting a complete profile. This is where TBA can come in handy, offering customizable solutions to cater to unique preferences.

The introduction of ERC is in line with the vision that NFTs will transition from being a collection item to a representation of digital identity and membership.



Source: [Benny Giang](#).

3. Growth NFT

The true uniqueness of each NFT lies in the individual experience that it offers. It is not merely defined by its tokenId, but also by its transaction history, which contributes to its

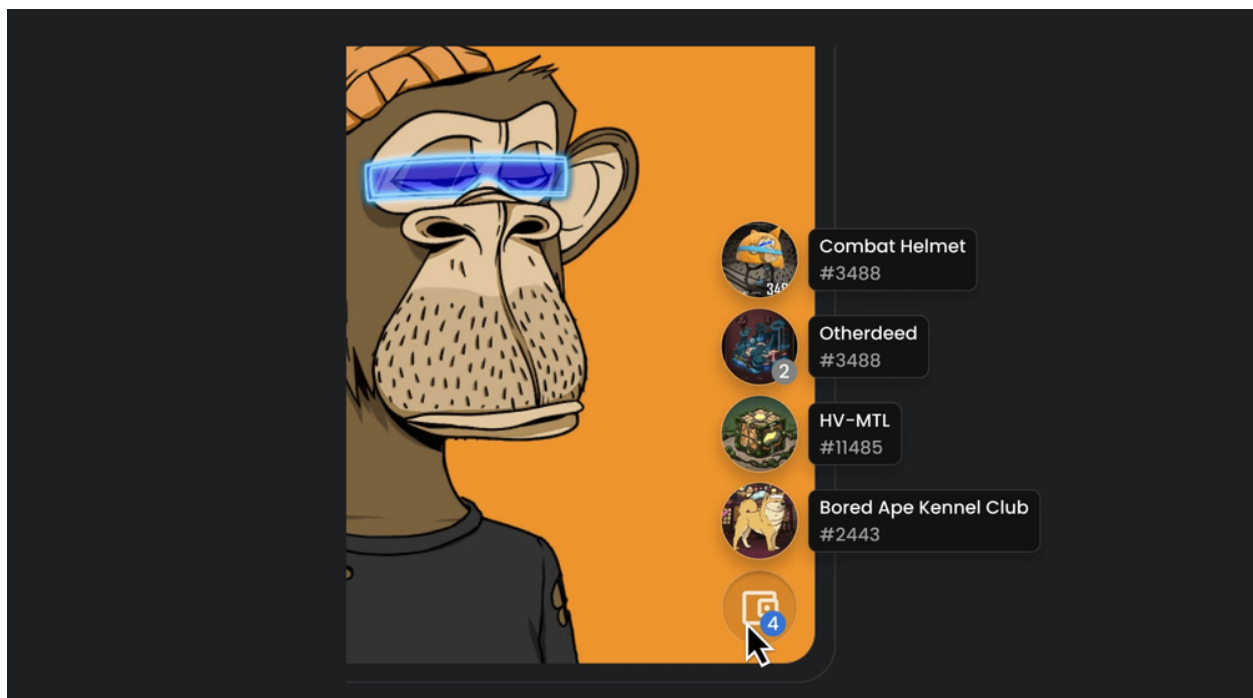
character. The more interactions one has with an NFT and the longer one holds it the more valuable and distinct it becomes.

This quality can be leveraged in DAO loyalty programs, where certain Proof of Attendance Protocol(POAPs) and Soulbound Tokens(SBTs) are only awarded upon completion of specific tasks or contributions to the DAO. To further enhance the connection to the DAO identity (represented by an NFT), these tokens should be associated with the DAO's NFT rather than an individual's personal wallet.

4. Assets management

A TBA is capable of storing a wide variety of assets, including ERC-20 tokens, NFTs, SBTs, POAPs, and more. By integrating tokens, assets, and NFTs into a single TBA, users can conveniently transfer assets and seamlessly switch platforms, creating a more user-friendly experience for asset transfers. For instance, users can sell an entire category of assets all at once, simplifying the process.

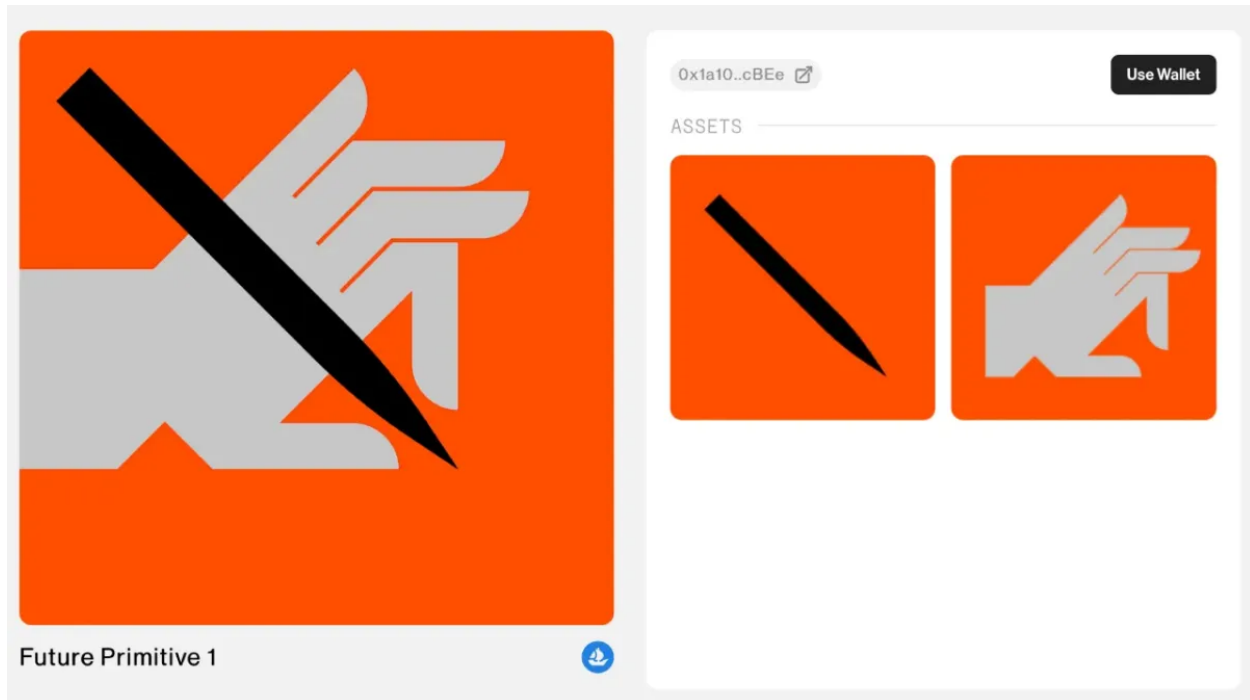
Moreover, a TBA also enables the categorization of assets based on their importance, allowing for easy asset management.



Source: [0xDesigner](#)

5. Dynamic NFT

Typically, NFTs contain static metadata in the form of a URL providing a statistic. However, because of the composability introduced by ERC-6551, NFTs can be disassembled and reconfigured in parts, allowing for the creation of custom NFTs consisting of other NFTs in your token-based account.



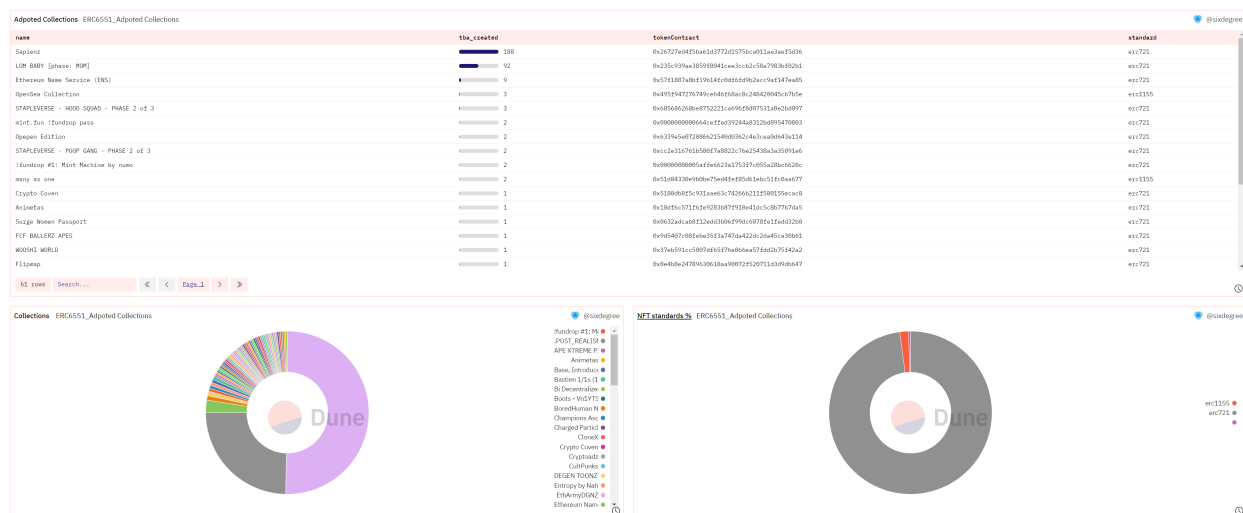
Source: tokenbound.org

Data Analysis

Based on recent data (June 13th, 2023), ERC-6551 has been adopted by 140 users who have created 415 token-bound accounts with 66 NFT collections. These figures show that ERC-6551 is still in its early stages, and it will be interesting to track its adoption. More data can be found on [Dune](#).

Although ERC-6551 supports all types of NFTs, a significant majority of token-bound accounts - 99% - are being created on top of ERC-721 tokens. Furthermore, half of all

TBAs are being created on top of Sapienz, which was the first company to launch a full-scale project using ERC-6551 protocol.



Source: [Dune](#)

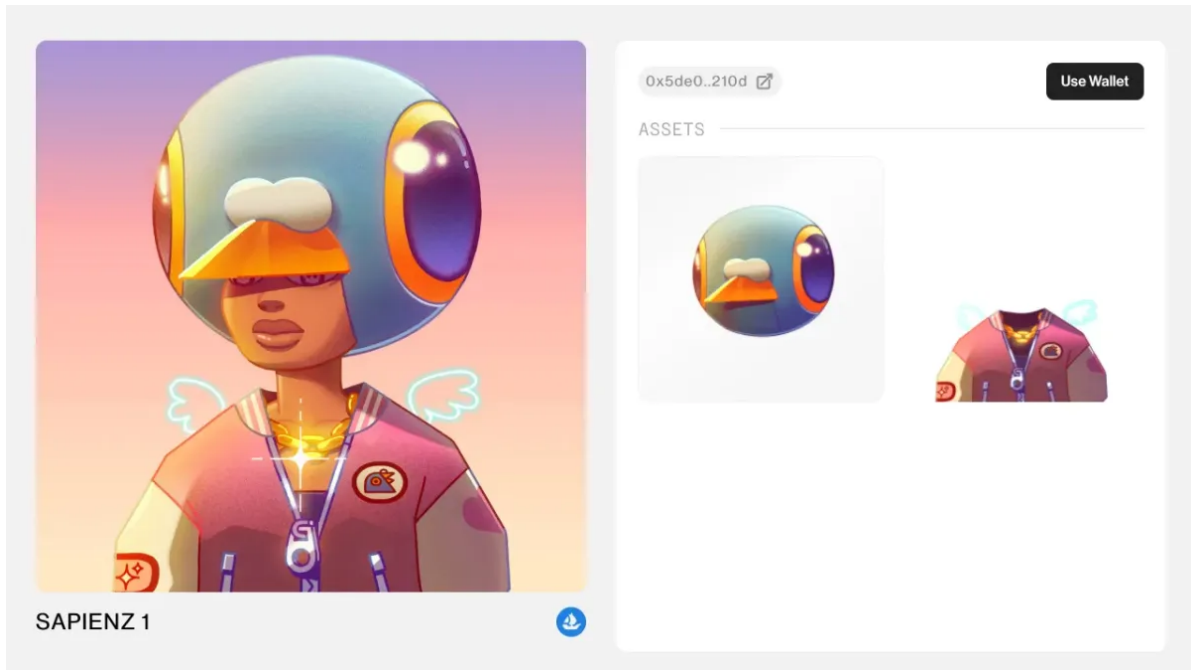
A number of TBAs are currently carrying valuable NFT assets, such as Azuki and Doodles, as well as FT assets like USDC. However, a majority of these TBAs were merely created and are not holding any assets at all.

Use Case Examples

1. SAPIENZ

Stapleverse is an early adopter of ERC-6551. Its pioneering initiative, known as Sapienz, constitutes one of the first projects to feature token-bound accounts. The incorporation of TBA in Sapienz enables each Sapienz to equip its own NFTs and allows for the Profile NFT to undergo a plethora of fashion-focused transformations, such as clothing and styles. This innovative approach facilitates the development of digital street culture and offers unparalleled flexibility in the realm of digital fashion.

As illustrated below, a Sapienz possesses a penguin helmet and a stylish jacket, which can be utilized to dress them up.

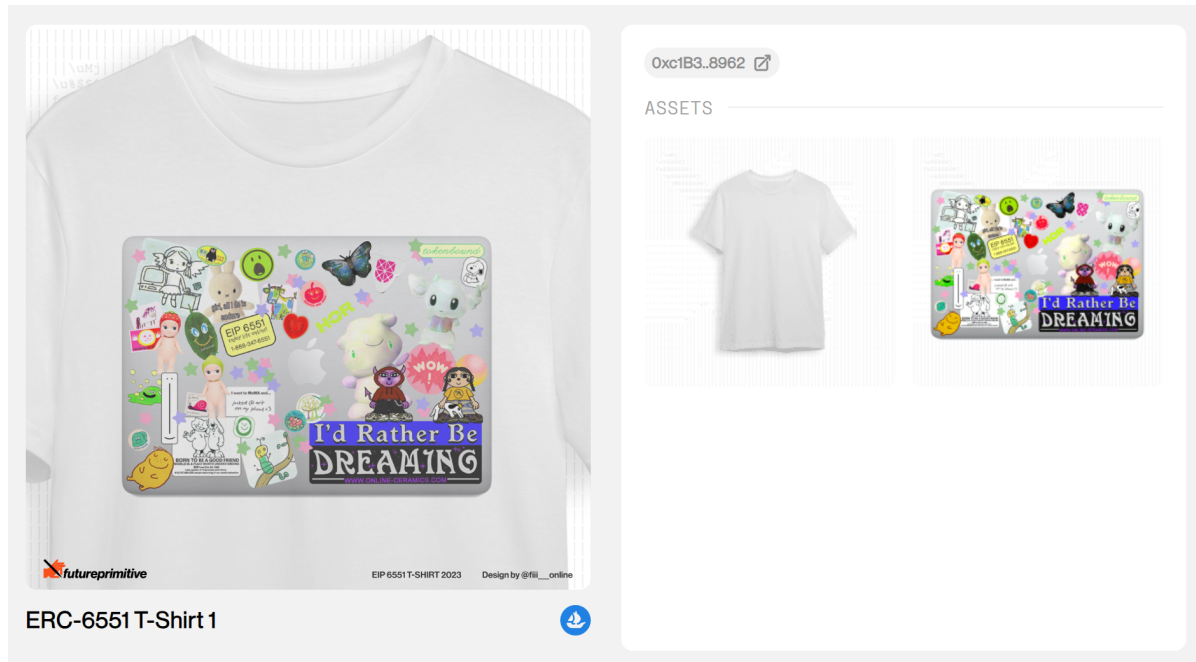


Source: [Sapienz](#)

2. ERC-6551 T-Shirt

The T-shirt exhibit consists of a base t-shirt and a logo/text overlay. This display can be altered whenever there is a modification in the NFT that TBA is holding.

ERC 6551 can help make virtual fashion more composable, which is an interesting development to watch. Established brands such as LVMH, Adidas, and Nike who are already present in the Web3 could use the standard to launch marketing initiatives.



Source: tokenbound.org

4. Parallel

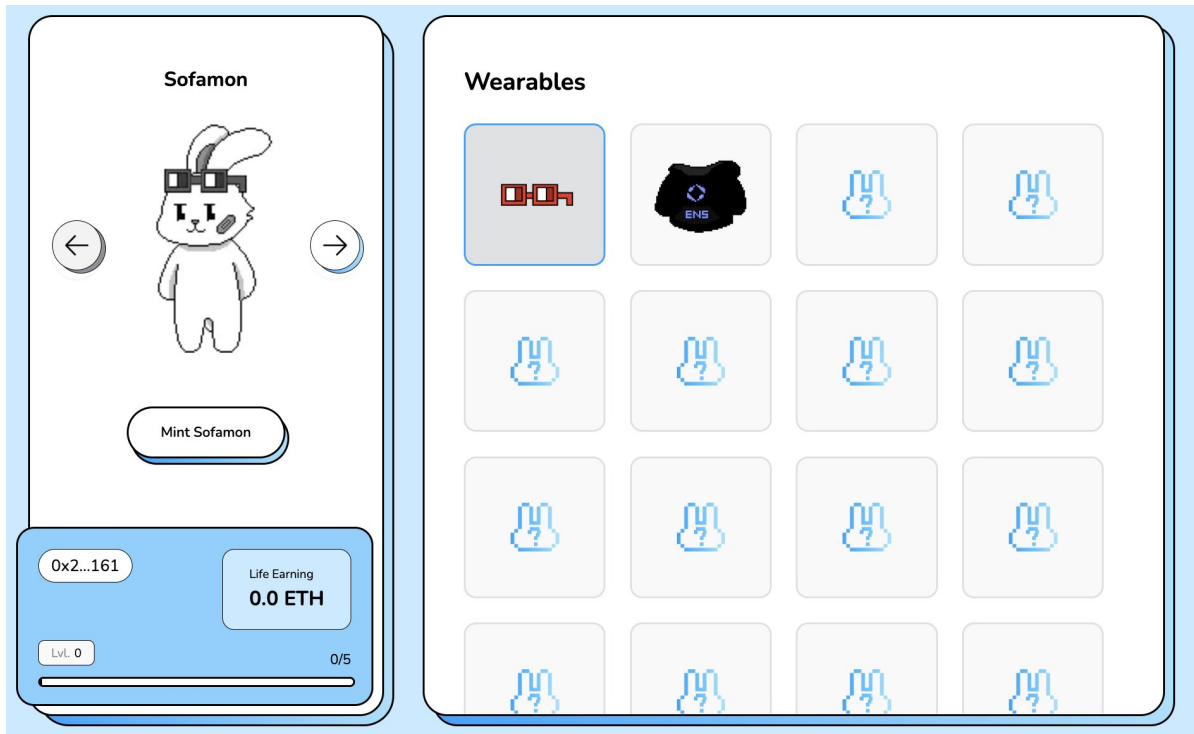
Parallel is both a Card Game and a Sci-Fi world where the power of ERC-6551 is harnessed to unite AI and crypto. The game is composed of AI avatars, equipped with a backpack that contains a combination of ERC20 and NFTs. With ERC-6551 the Avatar has full access to trade, sell, buy NFTs and ERC tokens and can interact with any onchain contract outside of the sim itself once it's aware of its existence. This is a very exciting instance of AI + blockchain Game + TBA.



Source: [Parallel](#)

5. Sofamon

Each wallet will receive a score measured by on-chain creative achievements on Zora, Nouns, Manifold, Mirror and many other crypto consumer protocols. By minting a rabbit-inspired avatar, users can associate all of their accessories with their on-chain wallet activities. The more active a user is on the platform, the more wearable items will be added to their avatar. As a result, the rabbit avatar will showcase all of the user's accessories and display its own unique modeling.



Source: [Sofascore](#)