

SUMMARY

Embodiments of the disclosure are directed to systems and methods for establishing the long-term authenticity of non-fungible tokens (NFT) minted on a public blockchain. In particular, various embodiments of the disclosure are directed to systems and methods for minting an NFT to possess, in addition to the typical digital signature produced via a public/private key pair, additional composition such that the NFT is object agnostic and persistently authenticatable across long spans of time. For example, various embodiments provide for systems and methods that establish the long-term authenticity of NFTs regardless as to whether the NFT is associated with a digital object, physical object, or intangible object, such as intellectual property assets, contracts, or other intangible assets, and allow for authentication in a variety of scenarios, such as when the associated object is not directly derived from the private key.

While it is generally the case that an NFT will be preserved on a public blockchain via a network of nodes and secured via the blockchain's consensus mechanism, such as proof of work, proof of stake, or other suitable consensus mechanism, there is no assurance that the NFT itself will preserve its ability to authenticate an associated object or its association with that object, particularly over long or very long periods of time. For example, traditional NFTs can typically only be authenticated against the possession of a private key via a public/private key pair. And while in some specific scenarios this information alone may be sufficient to authenticate the NFT, in many instances the NFT at least partially relies on one or more third parties to establish its association with a specific object. For example, often this responsibility is left to third party NFT exchanges, centralized databases, the private key holder, or to other entities.

As such, while there may be a high confidence in the ability of a blockchain to preserve and store the public key and digital signature information of the NFT along with any subsequent transaction data over long and very long periods of time – a blockchain cannot preserve information which the NFT does not itself include. As such, in many instances the blockchain will not preserve the linkage between the pseudo-anonymous public key or digital signature to the actual identity of the NFT minter. Further in many instances the blockchain will not preserve the association of the NFT with the object. And still further in many instances it will not contain enough information to ensure that the minter of the NFT was the originator or possessor of the object at the time of minting or had authority to mint the NFT on behalf or on the instructions of the originator or possessor of the object.

This is particularly a concern with regard objects that possess significant pre-blockchain history. In many instances, the pre-blockchain history is not maintained on the blockchain. This history is important to assist in independently verifying the authenticity of the NFT. Further, with regard to physical objects, such as physical art, or real estate, there is no information or documentation regarding appraised value or origin. In addition, with regard to physical objects the unique features that identify the specific object are not necessarily independently linked to the NFT. For digital objects the source construction resources and files are not linked and there are no certifications of authenticity or origin. Further, for digital NFTs, the ownership of the NFT or indication that the NFT was rightfully minted is not assured at the time of creation.

In addition, there is further concern with regard to intangible objects or other objects that possess contractual obligations or rights associated with their use. For example, for physical objects, the contracts, copyrights, rights for derivative works, etc. that exist have not been included at the time of minting. For digital objects, the rights to display, make derivative works, etc., are not established at the time of minting. Further, rights for use of the NFT itself are not clearly defined. Still further, with regard to both physical and digital objects, the NFT provides no assurance of long-term storage of the associated object. Since most objects exist “off-chain” the long-term storage of these assets must be persistent to ensure long-term value. Finally, NFTs currently provide insufficient acknowledgement and disclosure of smart contracts. For example, terms that will be auto-executed on the

blockchain may not be disclosed. For example, any terms that relate to future resale of the NFT, royalties, or the like. In instances where such terms are included in the NFT they are not necessarily formatted into a human readable and comprehensive list of terms. Also, when minting a “Back to Physical” NFT, the authenticity of the physical object must be assured and links to the parent NFT must be authenticatable.

As such, typical NFTs fail to possess sufficient composition in order to ensure that the minted NFT is authenticatable and persistent across time. In particular, none of the existing NFTs are minted with composition to ensure their authentication particularly with regard to items with physicality, or items that were not directly derived from the private key holder.

While relying on third parties to store and/or authenticate this information may not pose a significant risk over short periods of time, information can easily degrade over long enough periods of time. For example, third-party exchanges and centralized databases may suddenly cease to exist or the data which they store may become lost or compromised. As a result, the information relied on to tie the NFT to the object or to the identity of the minter can be lost. As such, over several decades or even over centuries the owner of an NFT, their descendants, and others may find it difficult to discern whether an NFT is authentic or what object the NFT is associated with, the pre-blockchain history, any contractual obligations or rights associated with the corresponding object, and even the location where the object itself is located. Without addressing these issues the long term value of NFTs will suffer.

As such, embodiments of the disclosure are directed to systems and methods for establishing the long-term authenticity of NFTs when minted on a public blockchain. In order to solve the technical problems for described above, embodiments will define the structure, composition and process of an authenticatable and persistent NFT to establish and maintain long-term value. This structure and composition is applied during the minting process of the NFT to ensure that the NFT is not corrupted, incomplete, or ambiguous. In various embodiments, a signed certificate from a trusted authority will be generated as evidence that this process has been properly performed.

One or more embodiments provide benefits in the form of a system and method for digital token based authentication of unique objects that allows for long term storage of authenticating tokens within a blockchain over decades or even centuries, so long as the blockchain itself remains in operation. Further, various embodiments provide benefits in that it generates long-term authenticatable NFTs on a public blockchain where the private key can be held by a third party or generated by a third party with permission while still allowing the NFT holder to verify its authenticity as to the source of the NFT. Such benefits are expected to be particularly useful as services and industry around NFTs and blockchain tokens develop where a private key is stored on behalf of the creator/owner of the object or the NFT is created by the third party on behalf of the creator/owner. In particular various embodiments of the disclosure provide benefits for minting, establishing, and maintaining long-term NFTs that are object agnostic. For example, various embodiments ensure long term authentication of NFTs that are associated with physical objects, sometimes referred to as a “Digital Twin”, or NFTs that are associated with digital objects or intangible assets.

As such, various embodiments of the disclosure are directed to systems and methods for longterm authentication of non-fungible tokens. In various embodiments the method includes providing within the non-fungible token a hash of an identification manifest that includes one or more elements of identifying information for a unique object and a digital certificate of a trusted certifying authority. Corresponding systems comprise an associated off-chain storage for long-term storing of the unhashed identification manifest. In one or more embodiments the one or more items of identifying information include at least one element that authenticates the unique object and at least one element that authenticates the owner of the object. In one or more embodiments the system further includes a blockchain network including a distributed blockchain recording a

non-fungible token located at a public address on the blockchain. In various embodiments the non-fungible token includes at least the hash of each of the one or more elements of identifying information. In certain embodiments, the nonfungible token can additionally include the unhashed identification manifest and/or the NFT certificate. In such embodiments, the non-fungible token is independently authenticatable by use of said hashes, against the one or more elements of identifying information in the off-chain storage system and/or by use of the unhashed identification manifest and/or by use of said NFT certificate against said certifying authority and/or a corresponding validating authority. In various embodiments the non-fungible token includes unhashed information including a location of said one or more elements of identifying information in the off-chain storage system.

The above summary is not intended to describe each illustrated embodiment or every implementation of the present disclosure.