FIND THE MISSING PIECE:

Adding Digital Preservation to the NFT Trading Ecosystem

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Abstract – The NFT (Non-fungible token) market is experiencing explosive growth. While artists, collectors, and crypto enthusiasts are jumping into this ecosystem, traditional collectors have found it more challenging to evaluate asset value in this NFT market than in the established collectible market. This paper navigates the reason for this problem by examining the design of NFT using ERC-721 and ERC-1155 standards, then illustrates that NFT's infrastructure makes its evaluation more challenging based on its unstable or lacking connection to the underlying digital assets, which makes the evaluation of NFT inconsistent. This paper will propose a revised business model with a workflow to add digital preservation to the NFT trading ecosystem. The paper suggests adding digital preservation clients to the Ethereum blockchain and building communication with the back-end digital preservation system to guarantee the stability of NFT's digital assets. In the end, this paper will discuss the benefits of the new business model and workflow, with potential future challenges and opportunities to the revised NFT market.

Keywords – non-fungible tokens (NFTs), digital preservation, metadata standard, NFT trading, NFT flaw

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I. INTRODUCTION

NFT (Non-fungible token) has gained substantial attention growth in the past few years. The global number of users was around 36.12m in 2021 and is projected to reach 64.45m users by 2027. The worldwide revenue is expected to reach $8068.99m in 2027 [1]. OpenSea, one of the most popular NFT marketspaces, had $467,608.18 in monthly sales in Feb 2023 [2].

While the interest in NFT collections and exchanges is growing, some museums have started experimenting with preserving NFTs. 'CryptoPunk 5293' (the work's title), an NFT used to rack up about $800 million worth of sales on the Ethereum blockchain exchange, was acquired as a gift from a trustee by ICA Miami in 2021 [3]. However, the broad market has not fully recognized the necessity of digital preservation, nor has it been explored by most digital preservation organizations.

Digital preservation, which combines policies, strategies, and actions to ensure access to reformatted and born-digital content over time [4], perfectly fits the needs of NFT traders who seek stabled long-term asset value in collectibles. On the tech side, the Digital preservation systems, such as LOCKSS Software and Archivematica, have been adopted by many large-scale organizations [5]. Many academic institutions also have high-proficiency digital preservation workforces to develop and maintain these systems [6]. Besides safeguarding the digital asset in NFT, digital preservation adds accountability to the NFT and ensures the cultural heritage and financial continuity

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of the NFT trading ecosystem. This paper aims to analyze the reasons for some dysfunctional and deficient trading behaviors in the current NFT market, then proposes a business model and the corresponding workflow to fix the problem. The goal is to introduce digital preservation into the NFT trading ecosystem to assume, validate, and maintain the underlying digital asset of NFTs. Adopting the proposed business model and workflow will provide the missing piece that the current NFT market needs to include in the traditional, thoroughly tested collectible market, and make the NFT market a more sustainable, resilient system with lasting health and vitality.

II. HISTORY OF NFT

Non-fungible tokens, or NFTs, are assets that have been tokenized on a blockchain and include unique identification metadata proving this token is distinctive. Unlike interchangeable tokens, NFTs could look identical but are non-interchangeable or non-fungible.

The history of NFT originated in 2012 when M. Rosenfeld introduced the concept of 'Colored Coin,' which represents physical assets such as money, real estate, or vehicles [7]. Two years later, Vitalik Buterin (the creator of Ethereum) and Fabian Vogelsteller introduced the ERC-20 standard for anyone to create tokens like 'Colored Coin' on the Ethereum blockchain [8].

In January 2018, etherum.org introduced the ERC-721 standard [9], which allowed people to create NFTs on the Ethereum blockchain and provided practical functionalities—these functionalities included transferring tokens from one account to another, returning the current token balance of an account and getting the total supply of the token available on the network. A significant amount of NFTs today are based on this standard. Ten months later, etherum.org published the ERC-1155 standard as the 'multiple token interface' [10], while the ERC-721 standard's token ID was the single non-fungible index. The ERC-1155 Multi Token Standard also allows each token ID to represent a new configurable token type. The majority of NFTs follow these two standards in today's market.

2.

III. HIDDEN TRAPS IN THE CURRENT NFT ECOSYSTEM

Although many artists, collectors, and traders welcome the rising NFT ecosystem, the overall trading activities are still far less sustainable and balanced than the mature, traditional collectible market. The current NFT market challenges classic collectors and new NFT investors to fully understand and reasonably trade NFTs. In September 2022, the NFT market saw volumes down 97 percent from eight months ago [11]. To revitalize the NFT trading ecosystem, researchers have identified several issues stemming from the design of NFT marketplaces. These include a complex user interface, a lack of comprehensive documentation and guidance, and a lack of continuity between different marketplace websites [12]. However, many NFT critics still claim that NFT is just a worthless concept [13]. Their arguments highlight two major flaws that originate from the design of NFTs themselves and cannot be rectified solely by enhancing user experiences:

A. The 'Real' Digital Object Doesn't Need to Exist

A common misleading concept about NFTs is that the NFT must represent some 'visible' digital objects, like art, game gadgets, or virtual land in a Metaverse. This is not the case because both ERC-721 (defined by *ERC721Metadata* interface) and ERC-1155 (defined by *ERC1155Medata_URI* interface) make the URI to digital asset optional [9], [10], which means that NFT is not guaranteed to have a visible digital object linked to it. Some NFTs use *IPFS*, a content-addressed, versioned P2P file system widely accepted as the blockchain file storage solution [14]. However, a persistent, always-valid file location is still not mandatory for NFT trading. Even *IPFS* is not required to always be responsive by these ERC-721 and ERC-1155 standards. Moreover, the URI to digital assets typically points to an off-chain host location where the NFT buyer has no control. The file server may not guarantee the long-term existence of digital support on the file server. Accordingly, some traditional collectors or NFT beginners could be surprised one day that their NFT image shows a '404 Error' instead. They may recognize later that it is acceptable for an NFT to have an 'inconsistent' actual digital asset. Still, their confidence in continuously fair trading in the NFT market could be hurt. Eventually, this situation will block the healthy circulation of NFTs in the ecosystem.

B. The Real Value of NFT Is from Metadata Collections

The fact that underlying digital assets are not necessarily tied to NFTs creates a distinction

between the NFT trading market and the traditional collectible market. Consequently, the pricing and value recognition in the NFT market differs from those in the traditional collectible market. Unlike traditional collectors who receive both proofs of ownership and physical collectibles through trading, NFT traders must understand that an NFT only represents proof of ownership and a record of the trading experience, thus the monetary value of NFTs tends to be associated with intangible attributes derived from the NFTs' metadata. For instance, a high trading price and numerous dramatic trading stories related to an NFT may reflect the current owner's social status, power, wealth, and fame, irrespective of the existence of the digital object. As a result, NFT evaluation becomes unpredictable, making the NFT ecosystem more susceptible to asset bubbles. The uncertainty in digital asset safety and its underlying value makes NFT items hard to evaluate, hurting the overall NFT system's stabilization and long-term sustainability.

IV. ADDING DIGITAL PRESERVATION TO THE NFT TRADING FLOW

To provide NFT owners with access to underlying digital assets, off-chain storage solutions are used, where digital objects are stored on file servers. Links in fields like ERC1155Metadata_URI or ERC721Metadata point to these off-chain file servers. These solutions enable efficient and decentralized storage of NFT-associated digital assets. However, blockchain-based off-chain storage also has drawbacks. It requires technical expertise for node infrastructure setup and maintenance, making it less accessible to non-technical users. Incentive systems tied to cryptocurrencies can be unstable, discouraging financial rewards. Insufficient active participants in the blockchain network increase the risk of data loss, posing a challenge to the persistence of digital assets. Thus, blockchain-based storage alone cannot guarantee long-term preservation [15].

But does this imply that traditional digital preservation solutions should directly compete with decentralized storage solutions in the NFT trading market? Not necessarily. Decentralized storage systems still offer distinct advantages to NFT traders, such as enhanced privacy and the absence of reliance on other nodes in the chain. Therefore, rather than engaging in a zero-sum game, digital preservation teams should focus on catering to a specific group of NFT traders who require continuous availability of associated digital assets. In a decentralized future, digital preservation players can explore new revenue streams by assuming roles as assurers, validators, and maintainers within the NFT trading ecosystem.

A.   Use Case Example and Business Model

The evolving roles of digital preservation teams will provide team members with a wider market to showcase their technological strengths. One potential use case lies in the training of Large Language Models (LLMs) within the future AI market. The emergence of ChatGPT has demonstrated the significance of LLMs in achieving improved training outcomes. For instance, the initial version of ChatGPT (GPT-3) was trained on approximately 570GB of source data [16]. DALL.E with Clip, the AI system capable of generating images from text descriptions, is trained on a dataset consisting of 400 million pairs of images and text [17]. but where do these images and texts, which serve as training sources for the Large Language Models (LLMs), originally come from? Although there hasn't been a consensus on the source of the data for LLM training, web crawlers, which are tools to gather data and images from websites without guaranteeing payment to the parties being scraped, serve as another significant source of LLM training data [18].

As more companies opt to develop their own LLMs, a concerning trend emerges. Images created by artists seeking to sell their work for profit are being utilized by machine learning models without compensation. Unfortunately, there is little artists can do to prevent their creative output from being used in the production of machine-learning AI models that have the potential to replace their own work.

A new business model for NFT trading, incorporating digital preservation technologies, can help prevent the future scenario, as depicted in Fig. 1. In this ecosystem, artists would create NFTs with digital assets stored using decentralized storage solutions such as *IPFS*, while incorporating digital preservation into the workflow. The introduction of digital preservation parties in the NFT ensures the long-term guarantee of the underlying digital asset's availability. Model trainers and other data buyers, who require continuous access to the underlying

data, would need to pay the NFT to access the privately encrypted digital asset for training and other profit-driven purposes. The additional value in this NFT, resulting from the involvement of the digital preservation side, is demonstrated and recognized by artists and digital preservation teams.
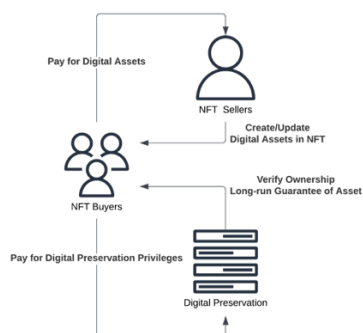

Fig. 1 NFT Trade Business Model with Digital Preservation

B.   Workflow

Since blockchain has natural characteristics of immutability and decentralization, all nodes on the chain mutually watch and maintain the significant metadata of blocks. Hence a light Ethereum client should be set up on the digital preservation side to keep connecting with the Ethereum blockchain. The *Metadata JSON Schema*, part of ERC standards for NFT [9],[10], defines the digital object location and other metadata for the underlying digital asset. The digital preservation system should thus store this part of metadata to ensure the proper amount of data is kept off-chain instead of adding a heavy burden to the existing storage infrastructure.

The proposed phases of the new trading flow are stated by 1) NFT's creation and updating and then 2) an NFT's owner requesting verification of visible digital assets in NFT, as illustrated in *Fig. 2:*
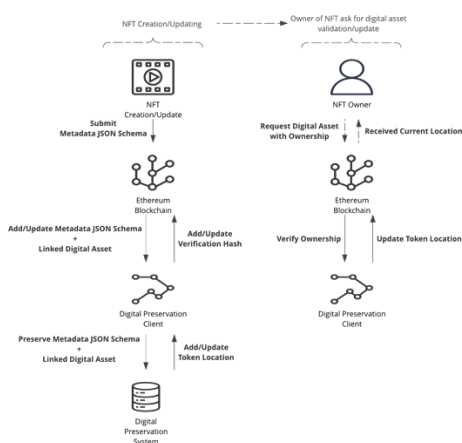

Fig. 2 NFT Trade Flow with Digital Preservation

A. NFT Creation or Updating

In this stage, the NFT is created or updated. An example NFT is a game card with a football player's score in alignment with the ERC-721 standard. When the card is made, the football player's initial score is shown on the GIF of the card. The GIF is stored as the image attribute, retrieved from the *tokenURI (unit256 _tokenId)* function under the ERC721MetaData interface. The image attribute will point to the updated GIF with a new score if the football player's score is updated. In these scenarios, the NFT's change will be admitted and recorded by the Ethereum blockchain. As a blockchain node, the digital preservation client will automatically be notified. The client then informs the data preservation system to update and store the updated digital asset. After the digital asset is well preserved, the digital preservation client submits an encrypted message to the blockchain to signify that the digital asset has been well maintained, including the preservation client's public address. All nodes record this verification to avoid future debuts. The digital preservation team is the digital asset watcher and keeper in this process.

B. The Owner of NFT Asks for Digital Asset Validation

This scenario occurs when the NFT owner notices that the *Metadata JSON Schema* does not reflect the correct digital asset. For example, the collector/owner of the game card sees that the GIF does not exist anymore. Then, the NFT owner messages the digital preservation address to ask for verification. The digital preservation client confirms the ownership using the NFT's metadata, then updates the digital asset address and sends the verification message again.   This process is automatically broadcasted to blockchain nodes. By doing this, the underlying digital assets are successfully ensured in the NFTs, avoiding the value's significate devaluation. The NFT owner and potential buyers can continue to assess the value of NFT using the certified, industrial-trusted, and regulated guidelines. This flow will increase the number of healthy trades and improve NFT market quality sustainably.

C. Benefits of The New Business Model and Workflow

The business model and workflow proposed in this paper fulfill the needs of all parties involved in the NFT trading process. Artists and NFT creators receive financial rewards for their creativity while

safeguarding their intellectual property, incentivizing them to contribute more original ideas to the art market. Conversely, NFT buyers, who require long-term assurance of the underlying digital asset, can access mature services provided by the digital preservation team. Additionally, the digital preservation team not only benefits from new revenue streams in the business model but also has opportunities to become part of the broad NFT community and gradually establish a reputation in the Web 3.0 era.

Meanwhile, this designated flow will not disrupt the current NFT ecosystem because it does not add anything new to the current NFT standards, such as ERC-721 and ERC-1155. Instead, this flow will add digital preservation as a distinct, trusted resource for interested NFT creators/owners to seek verification and safe, long-term digital asset maintenance.

The digital preservation client joins the blockchain network, meaning that if the blockchain upgrades in the future, the digital preservation clients can participate in the upgrading decisions, have chances to vote as other nodes and enjoy the benefits of the new blockchain infrastructure after upgrading.

V. POTENTIAL CHALLENGES AND FUTURE WORKS

The NFT market is still in the early stages of development. The proposed trading business model and workflow could face many potential challenges brought mainly by the uncertainty of the overall blockchain ecosystem. Two significant obstacles include regulatory uncertainty and possible environmental criticism.

NFT has yet to be entirely accepted in many countries and faces legal side ambiguities. For example, Russia does not support NFT in any form [19]. Digital preservation parties should prepare for possible debates before joining the workflow, especially arguments about intellectual property.

Blockchain society is working towards a more sustainable, eco-friendly architecture. Ethereum, as the major player in the NFT market, is expected to drop by a massive 99.988% and its carbon emissions by 99.982% after it switched to the 'Proof of Stake' algorithm in later 2022 [20]. However, governments and NGOs are still concerned about the massive energy consumption supporting blockchain systems' computational power [21]. The data preservation team should continuously collaborate with other stakeholders to optimize the workflow to become more energy efficient.

Besides seeking solutions to these two challenges, the future work for this paper can also focus on technical implementation details, such as selecting the appropriate preservation technology for different NFT digital assets. Technologies like archival packages, emulations, or media-independent assessments have been proposed for NFT digital preservation [22]. It would be valuable to verify their applications in various scenarios through further research.

Additionally, special use cases within the new business model should be carefully considered and evaluated when designing the technical system. For example, if a blockchain becomes compromised or inactive due to security attacks, legal requests, or lack of participants, NFT owners still require continuous access to the underlying digital assets. Should the digital preservation team maintain a full local copy of the blockchain to prepare for such cases? Alternatively, should they develop a cross-chain solution to back up NFTs on another active chain? Will the cross-chain solution break the creators' original purpose in the art [23]? There is ample opportunity for future researchers to explore and navigate the technical implementations within the framework of the new business model.

VI. CONCLUSION

Compared to the traditional healthy collectible market, the NFT ecosystem lacks long-term stability to the NFT's off-chain underlying digital asset, which can lead to irrational trading and market phishing. Digital preservation will make up this missing piece by ensuring that digital support remains accessible, usable, and trustworthy over time. The designated business model and workflow in this paper add data preservation teams to the NFT ecosystem. Data preservation will actively guide, verify, and steward digital assets to guarantee NFT owners get the real value they seek from the NFT item. By adding the critical digital preservation piece into the ecosystem, the NFT market will keep a healthy trading environment in the long run.

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