Generic-NFT: A Generic Non-Fungible Token Architecture for Flexible Value Transfer in Web3

Lingxiao Yang, Xuewen Dong, Yushu Zhang, Qiang Qu, Wei Tong, Yulong Shen

***Abstract*—Non-Fungible Tokens (NFTs) do hold the promise of providing Web3 with the opportunity for self-sovereignty of users' physical assets. However, existing NFT marketplaces lack a generic design that allows the value of assets to flow efficiently. In this paper, we propose a generic NFT architecture for Web3. The architecture supports the rapid development of the upper application environment and automated value mapping of the underlying physical asset environment. To connect these two environments, a generic connecter has been designed to provide flexible storage for mapping data management, and to support universal cross-chain transactions. With these features, the values of heterogeneous physical assets can coexist in a unified Web3 world, and rich value transfer services can be developed on demand. This paper discusses the background of the proposed architecture, the open problems and our initial solution, as well as our design principles and advantages, and finally validates this novel NFT architecture.**

I. Introduction

The development of user-centric Web3 is still in its infancy. To solve the current situation where Internet giants monopolize the power of using user data, Web3 has established a decentralized identifier (DID) to link data with users in form of DID document [1]. Do user assets need to be similarly decentralized representation in Web3? The answer is yes. User assets are mainly divided into cash and physical assets with a certain market value. For the average individual in modern society, the value of physical assets they hold is often much greater than that of cash assets. Blockchain cryptocurrencies or called Fungible Tokens (FTs), can represent cash assets in a decentralized manner, and FTs have basically achieved cross-chain value exchange. However, most physical assets in the real world are illiquid, and important assets require centralized corroboration. For example, the confirmation of real estate needs to rely on the registration of the housing authority. Non-Fungible Token (NFT) offers a promising solution to decentralize the representation of physical assets [2]. It is a unique data unit stored on the blockchain, which has better liquidity and can be traded efficiently and atomically. NFT is confirmed by blockchain and cryptography so that no one can forge assets.

NFTs have been widely adopted in various crucial Web3 systems such as decentralized game industry, online event, collection trading, and the Metaverse [3]. NFTs aim to enable the value mapping of users' digital and physical assets (such as houses, cars, collectibles, and even DIY images and game props) as their unique identifiers. Users can customize the value of NFT based on digital attributes such as the rarity and liquidity of physical assets, and trade them freely. For example, on the OpenSea NFT marketplace, users can mint NFTs and trade NFTs using Ethereum.

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Different NFT ecosystems are developed based on divergent blockchain smart contracts, protocols, and standards. Currently, the mainstream NFT systems are developed with Ethereum as the underlying blockchain, and some are developed based on other public blockchains such as Polygon and permissioned blockchains such as Ant Chain. The lack of generic blockchain infrastructure and unified development standards have resulted in fragmented NFT ecosystems, which brings the following three problems:

- *NFT transactions are only between different users of a specific blockchain, and different NFT ecosystems are isolated.* As the current NFT system is tightly coupled to its underlying blockchain platform, different NFTs link to their unique blockchain addresses as evidence of their persistent correlation.
- *Differences between platforms bring about the issue of untrustworthy value mapping of physical assets.* How to convince buyers that the physical assets associated with NFTs on other platforms are tangible?
- *The usability of NFTs is severely challenged by the performance of the underlying blockchain.* Complex on-chain operations and highly congested blockchains cause expensive transaction fees and long confirmation latency that limit the widespread adoption of NFTs.

To address the above problems, a generic, asset-trusted mapping and efficient NFT architecture is necessary for sustainable Web3 economic development. Some NFT trading marketplaces, such as OpenSea, Rarible, and LooksRare, have been launched to be compatible with different underlying blockchains and protocols to realize NFT heterogeneous transactions. These platforms mainly focus on designing user-oriented graphical interfaces for NFT release, display and trading based on a single core underlying blockchain. At the same time, they are gradually adapted by developers to provide support for a few cross-chain NFT transactions. However, as their inherent strong coupling to the supporting blockchain infrastructure, different platforms may not be compatible with each other. Existing marketplaces mainly support digital asset trading and lack a trusted mapping design for physical assets.

In context, this paper proposes a generic NFT architecture, called Generic-NFT, which is suitable for all types of NFTs for heterogeneous cross-chain high-performance flexible value

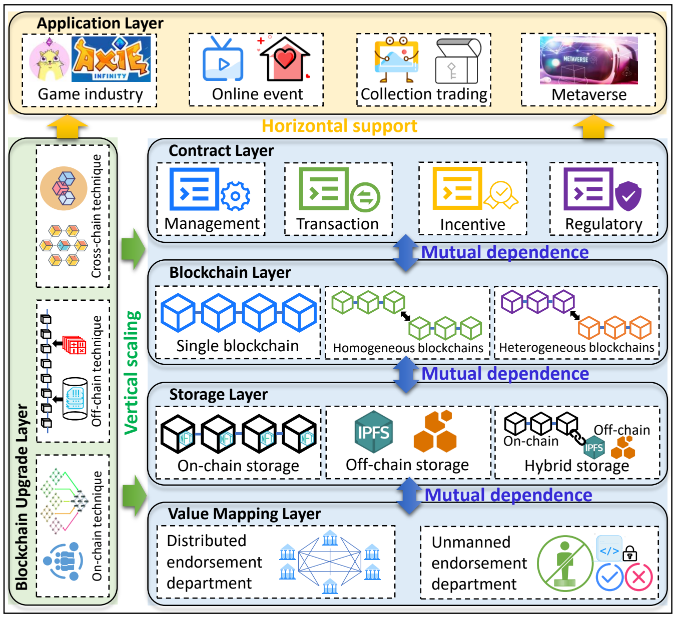

Fig. 1. Illustration of the proposed macro-architecture in Web3.

transfer. We illustrate in Fig. 1 the macro-architecture of Generic-NFT, which implements generic capabilities in two dimensions. First, the *application layer* demonstrates four industries where NFT is applicable, with multiple isolated NFT ecosystems existing in each industry due to their reliance on heterogeneous blockchains. Then, horizontally, Generic-NFT bridges these NFT ecosystems by integrating asset value mapping, multi-modal storage, blockchain, and smart contract technologies. The *value mapping layer* includes two modes of distributed and unmanned endorsement departments. The *storage layer* includes on-chain, off-chain, and hybrid storage. The *blockchain layer* includes single, homogeneous and heterogeneous blockchains. The *contract layer* includes management, transaction, incentive, and regulatory contract interfaces. Finally, vertically, the *blockchain upgrade layer* "upgrades" the underlying blockchain of Web3 with adaptive scalable techniques to provide high usability for Generic-NFT [4]. On-chain technique includes consensus mechanism improvements and sharding mechanisms. Off-chain technique includes state channel and off-chain computing mechanisms. Cross-chain technique includes relay-based and relay-free cross-chain mechanisms. The above-mentioned layers are complementary to each other, and we expand on the specific techniques they should apply in §III and §IV.

In the rest of this article, we first analyze the traditional NFT trading platform architecture, and the design directions of the existing architecture. We then introduce the Generic-NFT architecture and potential solutions. Finally, this paper provides a case study of a supported cross-platform NFT transaction to demonstrate the benefits of Generic-NFT.

II. NFT: Challenges and Opportunities

A. State of the Art

Fig. 2 illustrates the traditional NFT transaction architecture. This architecture logically consists of three layers: blockchain

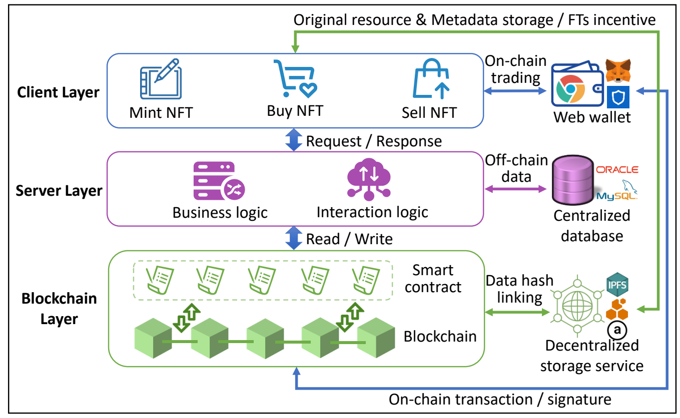

Fig. 2. Traditional three-layer NFT architecture.

layer, server layer, and client layer. The blockchain layer provides persistent ledger storage through mainnet nodes, and smart contracts provide the server layer with the ability to read and write on-chain data. Distributed storage solutions such as IPFS [5] earn incentive FTs by providing NFTs distributed storage services to clients. The server layer implements the business and interaction logic required by the client layer, and centrally stores data that does not need to be recorded on-chain. The client layer provides web browser user interfaces such as minting, buying, and selling NFTs. Each client connects to the blockchain through a web wallet such as MetaMask and uses it to sign client transactions.

The general approach to developing an NFT trading system is comprehensively designing these three layers according to specific NFT item requirements. More specifically, developers first select a suitable underlying blockchain as the infrastructure to provide persistent on-chain storage, then design smart contracts to enable platform business to interface with on-chain data, and finally design the platform's back-end logic and front-end interaction interface to implement various types of NFT transaction functions. However, existing NFT platforms tend to rely on a single underlying blockchain, which is prone to transaction monopoly and congestion phenomena. Moreover, existing NFT platforms are limited to trading digital collectibles/virtual art and lack consideration of value mapping for physical assets in the real world.

B. Open Problems

While developing a trading platform based on the above three-layer NFT architecture seems straightforward, it has several issues that hinder sustainable development. We summarize these issues as follows.

Vulnerability with Physical Asset Value Mapping: The blockchain layer can persistently store the NFT assets mapped data, and the multi-party consensus makes the on-chain data tamper-proof. However, the on-chain process of physical assets is vulnerable. The asset information before consensus may have been artificially tampered with. For example, real estate, essentially a centralized physical asset, is characterized on-chain in the form of NFT. The value mapping process must rely on the endorsement of a centralized agency such as the housing authority. How to ensure that the endorsement process of the housing authority is authentic and credible? Thus, the value mapping of Web3 needs to consider the issue of trustworthiness in the mapping process.

Difficulty with NFT Infrastructure Compatibility: (i) Horizontal cross-chain compatibility. Currently, NFTs minted on a particular platform can usually only be circulated within its ecosystem. Different types of NFT assets require different storage and transaction frameworks, which means that different underlying blockchain infrastructures must be compatible. (ii) Vertical backward update compatibility. The most common type is the static NFT, whose metadata is immutable after minting and cannot meet continuously updated scenarios (e.g., game props). The industry has introduced dynamic NFT (dNFT) that can trigger smart contract instructions to change metadata based on external conditions. However, smart contracts cannot be updated after deployment either, thus NFT infrastructure compatibility is a direction worth exploring.

Diverse Application Usability Challenges: NFT applications are tightly coupled with their underlying blockchains, leading to their usability, such as transaction latency limited by the performance of public blockchains. A fair application environment also falls under the category of usability. Diversified applications have various security risks. For example, in the currently existing wash trading, sellers inflate the value of their NFTs by continuously reselling them between different addresses, thus affecting the fairness of transactions. However, there is a lack of clear regulations and regulatory means for the legality of participants' operations.

C. Future Trends

As blockchain technology and Web3 applications evolve, industry and academia need to establish a generic architecture to solve the above main problems. We summarize some clear design trends.

Ubiquitous automated value mapping: If the physical assets are likened to capillary ends, their ubiquitous value mapping is the data source that supplies blood to the whole NFT system. As multiple NFTs based on heterogeneous infrastructures coexist, the new architecture design should support ubiquitous value mapping compatible with different NFT protocols. Blockchain sharding technology can effectively scale the network. For example, the Blockchain Network-enabled Satellite Internet of Things (BNS-IoT) sharding scalable scheme [6] provides a global high-performance blockchain coverage. This also provides Web3 with an opportunity for ubiquitous access to the blockchain. Moreover, automated access should provide a programmable interface to perform unmanned intelligent NFT value mapping operations backed by trusted hardware. For example, Liu et al. [7] used Trusted Execution Environment (TEE) to upload off-chain data to the blockchain in a trusted and efficient manner. Thus, this trend can efficiently solve the trustworthiness problem in the value mapping process.

Fusion of flexible NFT storage and universal cross-chain: Flexible data storage provides stable management capability for multiple types of assets after value mapping. Universal cross-chain further enhances the ability to flow value for massive assets [8]–[10]. The fusion of NFT storage and cross-chain creates a unified core that can string the logic of Web3. As an element that connects the real and cyber worlds, the core provides a pool of value with various combined operations that help hide the complexity and heterogeneity of the underlying infrastructure. This trend suggests that NFT architecture should build a connectivity core for southbound value mapping and interoperability between northbound applications.

The northbound NFT marketplace environment should be an abstract model independent of a specific platform, decomposing the overall business into multiple microservices, each of which can be developed, deployed, and run independently [11], [12]. This model enables developers to customize and reuse existing microservices to construct composite services according to their needs, thereby significantly reducing development and maintenance costs. Thus, support for microservice extension should be a built-in feature of modern NFT architecture.

The core of the southbound value mapping environment is dissemination and exchange. The value of dissemination has multiple content mapping presentation modes, and the exchange of value promotes the liquidity of the economic system. Thus, supporting the interoperability of different underlying blockchain systems is key to enabling large-scale Web3 applications.

III. Generic-NFT: Architecture Overview

To further explain the architecture shown in Fig. 1, we show the three-layer micro-architecture of Generic-NFT in Fig. 3, which consists of three environments. The Web3 application and value mapping environments are concatenated through a generic connector environment.

Value Mapping Environment: This environment is first proposed to support different types of physical assets for value mapping with different NFT standards, which involves the value mapping, blockchain, contract, and blockchain upgrade layers of Fig. 1. The mapping process includes the following steps. (i) According to the asset types, value mapping services for massive off-chain assets are provided based on sharding technology. (ii) The mapping smart contract interfaces of ubiquitous shardings parse and transform different standard mapping inputs. (iii) The unified mapping data is sent to the unattended automatic endorsement access devices for metadata verification, endorsement, and upload. The validation process is performed securely within multiple programmable black boxes to determine the correctness and integrity of mapping inputs to physical assets. Thus, users can map their physical assets indiscriminately without worrying about the platform's design specifications.

Generic Connector Environment: This environment bridges the gap between value mapping and application environments, which involves the storage, blockchain, contract, and blockchain upgrade layers in Fig. 1. The connector consists of two core components. *(i) Flexible storage component* provides an optional way to store southbound mapped physical assets in three separate resource pools according to category and user security requirements. *1) Blockchain ledger* offers the highest level of security, but requires users to pay high

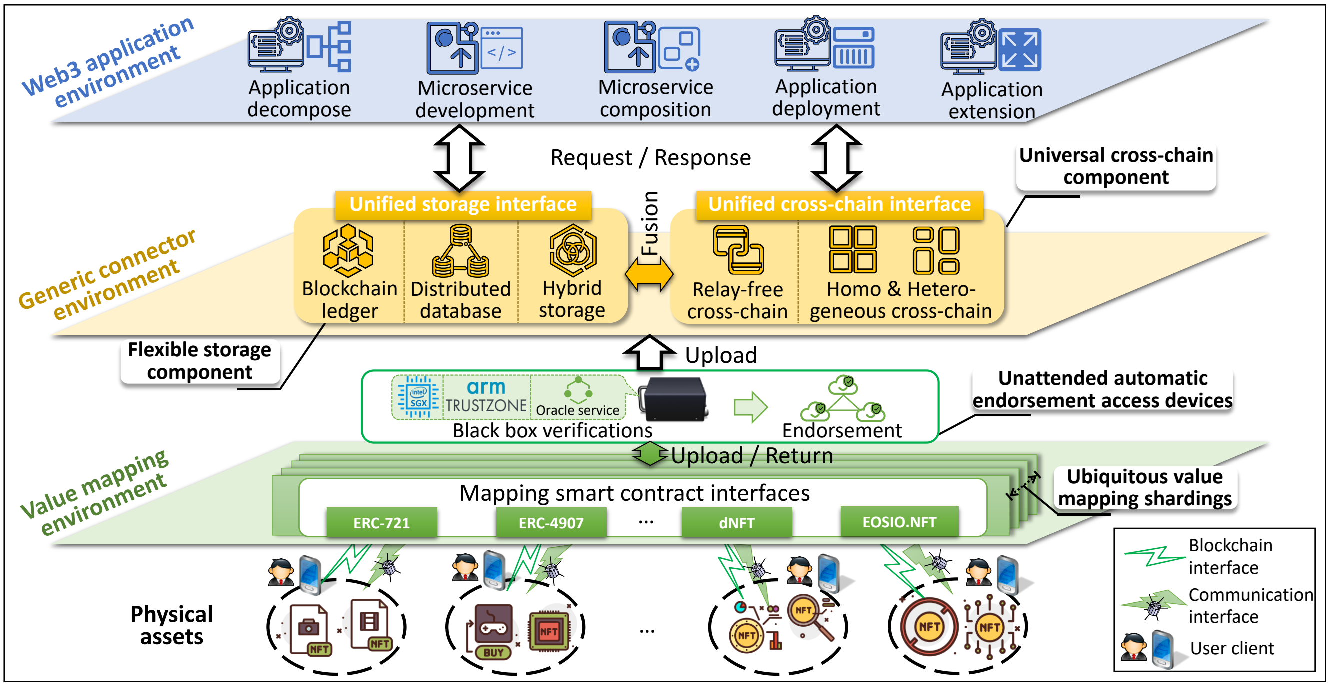

Fig. 3. Three-layer micro-architecture of Generic-NFT.

fees and endure slow storage speeds. *2) Distributed database* storage refers to an IPFS-like model of off-chain storage, which requires proof of existence to verify the integrity of the data. *3) Hybrid storage* means storing original asset data off-chain and storing metadata on-chain. *(ii) Universal cross-chain component* links data from the storage component, and provides a relay-free universal cross-chain transaction functionality, including the cross-chain of homogeneous and heterogeneous resources. Universality ensures that assets can be traded using any underlying blockchain to support economic flows across the NFT architecture. In addition, the cross-chain component provides high-availability support for value flow by integrating adaptive blockchain scalability techniques.

Web3 Application Environment: Since the generic connector environment hides the underlying differences, this environment supports the custom connection logic for NFT service platforms. Developers decompose the application according to requirements, and then develop and compose microservices. Applications also support functional extensions after deployment. As the environment supports the reuse of microservices, different stakeholders can share the provided microservice programs, and for complex business logic, they can also quickly build value-added functions on top of existing applications. Thus, this environment builds a unified NFT service ecosystem for Web3.

IV. Generic-NFT: Solution Design

The previous section introduced Generic-NFT to coordinate value mapping and application development through a generic connector. Next, we illustrate how to instantiate such an architecture. To this end, we propose a set of design principles as the building blocks of the architecture and give implementation solutions.

A. Value Mapping Environment Design

The value mapping environment has two design objectives. **Objective 1 (O1):** *Aim to interact with physical asset owners directly.* Compared with traditional Internet data collection, the design of the Web3 value mapping is more difficult due to the heterogeneity of physical assets. **O2:** *The mapped data should be credibly and traceably verified.* Thus, we summarize design **Principle 1 (P1)**: *Enable ubiquitous and automated access to physical assets.*

To achieve **O1**, the mapping layer should abstract the mapping object so that end-owners can freely map off-chain assets. We design ubiquitous value mapping shardings. The multi-modal (including the different NFT protocols shown in Fig. 3) mapping smart contract front-end inside each sharding provides participants with BNS-IoT-like blockchain and Starlink communication interfaces. The contract back-end interface transforms the aggregated mapping data into a generic, scalable format and then transmits it to the access devices. In addition, the mapping interfaces of the ubiquitous sharding can be further placed in different locations for large-scale deployment. Thus the physical asset owners can interact with the mapping interface directly through the clients.

To achieve **O2**, we design unmanned automatic endorsement access devices. (i) Devices first parse the unified mapping data. (ii) Multiple black boxes deploying smart contracts verify the validity of the mapped data. Each black box enables TEE (e.g., Intel SGX and ARM TrustZone) to guarantee the confidentiality and correctness of the verification, and accesses the trusted oracle service to verify the authenticity of the off-chain data. (iii) After the multi-dimensional verification is passed, the device performs multi-party consensus on the mapping data and distributed endorsement of the verification results, and finally uploads the formatted asset metadata to the connector environment.

B. Generic Connector Environment Design

The generic connector is designed to achieve two objectives, **O3:** *flexible storage* and **O4:** *universal cross-chain*.

For **O3**, we propose **P2:** *Provide a unified framework for heterogeneous asset data storage and management.* With the rapid growth of mapped data volumes, the storage component needs to provide high-throughput management for massive amounts of asset data.

Asset data are mapped from different sources with different protocols, and the storage component classifies, stores, and manages them according to categories (e.g., physical, digital, and virtual assets) and security levels (e.g., public, internal, and restricted data). The component design includes the following steps. (i) We adapt a hybrid blockchain distributed transparent storage architecture proposed by Tong et al. [13]. Different privacy-preserving storage policies are provided for different data security levels, and a concurrent transaction processing mechanism is designed to enhance the throughput of access transactions. (ii) To enhance fault tolerance, a reputation-based practical byzantine-fault-tolerance (R-PBFT) hierarchical sharding consensus protocol is designed based on the data owner's reputation. (iii) We adopt and improve an approach proposed by Ge et al. [14] to decide where to store mapped data. We analyze the trade-offs of different strategies (e.g., storage indexing, hot and cold data adjustment, data compression migration) on the performance of the hybrid blockchain database. Thus, the storage component provides smart storage management with flexible high throughput.

For **O4**, we propose **P3:** *Provide a universal cross-chain to support Internet of Everything transactions.* Cross-chain component design should support universality to enhance connectivity to different heterogeneous asset data and applications.

To achieve **O4**, Generic-NFT supports the following three features. *(i) Relay-free cross-chain.* As the relay-based cross-chain model is built on trust in the intermediary and requires complex adaptation by relays, its generality is poor. Web3's Internet of Everything should be trustless or trust based on cryptography. To achieve this vision, proper adaptations to existing blockchain systems are necessary, and key building blocks include the following. 1) Support for a sidechain cross-chain model based on zero-knowledge proof. 2) Support for aggregate signature to reduce cross-chain verification costs. 3) Support for verifiable delay function (VDF) to ensure the validity of cross-chain proofs. Thus, the component provides generic and efficient cross-chain interoperability in a relay-free, privacy-preserving, and loosely coupled manner. *(ii) Suitable user incentives.* Cross-chain incentives include: 1) Liquidity incentives to NFT minters. 2) Service incentives to storage providers. Thus, promoting the enthusiasm of participants within the ecosystem. *(iii) Excellent scalability.* We integrate adaptive blockchain scalability technologies. 1) Processing common cross-chain transactions by sharding according to different domains and using secondary consensus. 2) Batch processing of high-frequency cross-chain transactions using the state channel technique. Thus, the high usability of cross-chain component further supports Web3 massive interoperability and ensures the stability of economic flow.

C. Application Environment Design

This environment provides applications for multiple stakeholders, which should achieve **O5:** *Support the entire application lifecycle, including development, deployment, extension, and maintenance.* Thus, we propose **P4:** *Provide a complete ecosystem for Web3 application development and maintenance.*

To achieve **O5**, we build a microservice-oriented ecosystem design paradigm: (i) Developers should first divide stateless and stateful services based on business dependency on data sharing. This allows stateless business logic services to easily scale horizontally and stateful services to scale dynamically on demand. (ii) Then, developers smoothly implement service containerization and container orchestration. The communication between services is handled by service mesh, thus shielding the distributed system from communication complexity. (iii) Developers weigh the complexity overhead of the granularity of service splitting against the overall benefits of the ecosystem, ultimately achieving dynamic optimality of data partitioning and cluster load. (iv) The ecosystem provides decentralized service governance. Governance includes service cycle dependency, redundant service cleanup, and service behavior regulation. Distributed Autonomous Organization (DAO) members reach a consensus on multi-party governance decision proposals. They then use smart contracts and open-source coding to develop governance rules, forming an automated distributed governance mechanism.

V. Case Study and Validation

A. Selected Scenario

To further illustrate the advantages of Generic-NFT, we conduct a case study and analysis. Fig. 4 presents selected scenarios of deploying four practical NFT systems in our architecture: game industry, event ticket, collection trading, and material donation.

In the above scenarios, these four systems perform the same processing flow: (i) Various assets are input for value mapping through the mapping smart contract interfaces. (ii) Designing microservices for applications based on the business and interaction logic required by scenarios. (iii) A generic connector binds mapping inputs and microservices for flexible storage and management of mapping data and assets, and provides high-throughput interoperability support.

B. Architecture Validation

Value Mapping: Prop trading in the game finance (GameFi) industry reflects the need for players to circulate the value of virtual assets. Various blockchain games are developed on-demand following different NFT protocols. For example, the ERC-721 guarantees that each *CryptoKitty* is unique, and the ERC-1155 allows *War of Crypto* to create repetitive items like "potions". After accessing the value mapping shardings in games, players can select their props for value mapping.

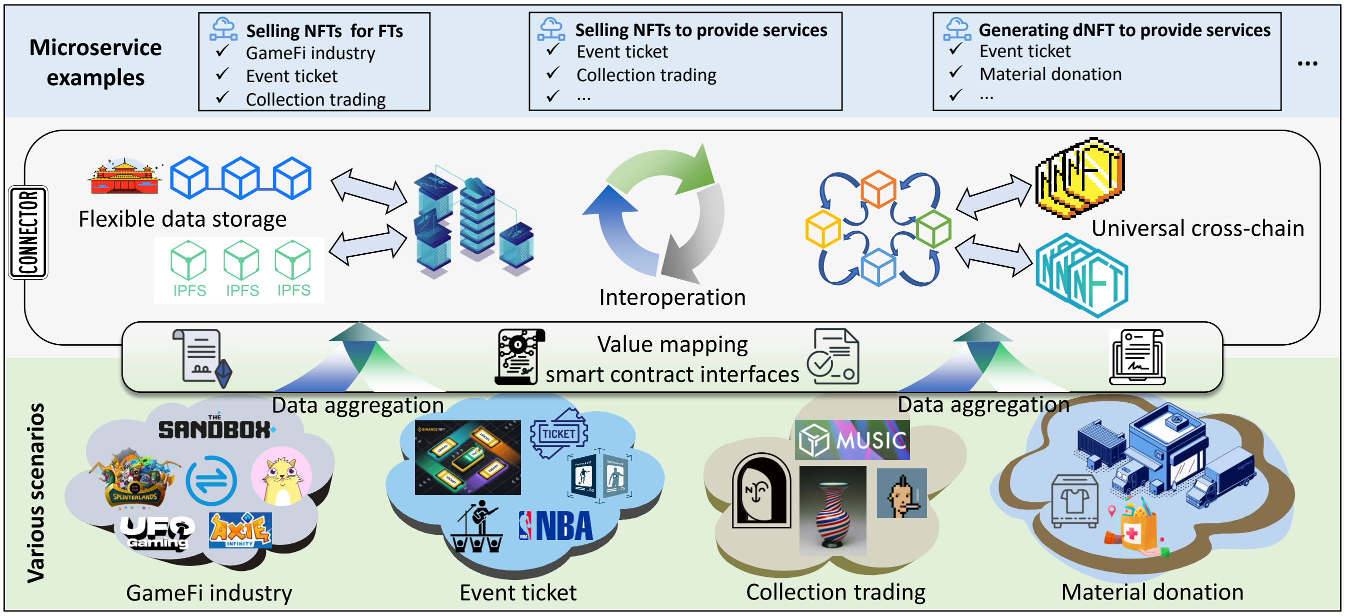

Fig. 4. Implementation of multiple NFT systems with Generic-NFT architecture.

Since each player's information is publicly available on the blockchain, the endorsement access device can directly verify its validity.

The assets donated in the material donation scenario are spread worldwide. With the blockchain and communication services provided by BNS-IoT and Starlink, donors can even connect to value mapping shardings in remote regions. Mapping materials involves logistics transportation. Hence automatic endorsement access devices can be set up in logistics points (multiple black box processes ensure trusted mapping). After automated scanning, the material data is transferred to devices for verification. The generated material dNFT is dynamically updated according to the logistics information, ensuring the transparency and openness of asset flow.

Flexible Storage: We consider the collection trading scenario. In this case, the storage objects include digital art (e.g., e-paintings) and physical collections (e.g., antiques). Digital art can be stored intact on the blockchain depending on the storage size and security requirements. Alternatively, their original data are stored off-chain distributively, with hash roots stored on-chain. Physical collections are stored in a hybrid way, with the small-size metadata (e.g., collection certificates) stored on-chain and physical objects preserved in off-chain trusted institutions such as museums.

Universal Cross-chain: The core of the universal cross-chain is to abandon the traditional intermediary trust structure. In the event ticket scenario, traditional ticketing relies on centralized institutions, where reselling and fraud issues have been the norm. Using blockchain and cryptography, universal NFT tickets that can be traded across platforms return market control to the venue and performer. In addition, dNFT tickets can trigger incentives to fans based on live events, leading to a better experience.

Application Lifecycle: The microservice-oriented design paradigm supports the entire lifecycle of diverse applications. In Fig. 4, *selling NFTs for FTs* is the most common microservice that systems can share in multiple domains, such as the game, ticketing, and collection. Moreover, microservices composition can provide value-added applications. For example, composing a microservice that *generates dNFTs* with a *selling ticket* service can provide dynamic application services during an event.

From these scenarios, we conclude that the intuitive advantages of Generic-NFT include the following aspects: (i) The unified architecture can support massive asset value mapping in multiple domains. (ii) Various assets can be flexibly stored and freely traded. (iii) Multiple systems can be rapidly deployed based on existing shared microservice applications.

C. Experimental Evaluation and Analysis

Based on the Generic-NFT, we implemented an application that supports NFT transactions for multiple assets (e.g., patents, music, e-paintings), which is evaluated as follows.

Evaluation Setup. Our architecture runs on two machines based on a 6-core 12-thread i7-10500 CPU, 16 GB RAM, and 480 GB SSD.

On-chain environment. Based on Docker containerization technique, we build two independent blockchain clusters, Hyperledger Fabric and FISCO BCOS (16 nodes per cluster and four participating in consensus). We apply the techniques described in §IV-B to implement network hierarchical sharding extension (Ref. [13]) and the universal cross-chain component.

Off-chain environment. we execute the core verification logic code of asset mapping in TEE (Intel SGX) to realize the trusted mapping process of assets from off-chain to on-chain. We use IPFS to simulate the distributed storage of asset source files. For example, patent certificate files are managed off-chain in a distributed manner.

Value Mapping Results. For the trusted mapping of assets, we evaluate the verification elapsed time for the first mapping and update (ownership change) in TEE of 10,000 asset

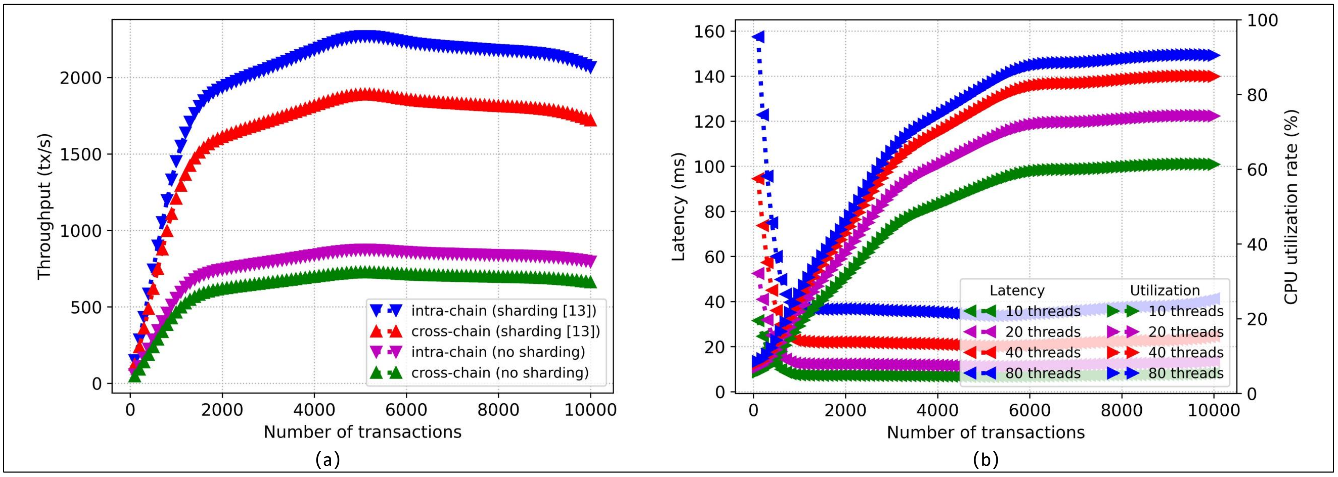

Fig. 5. Performance evaluation of Generic-NFT: a) the system average throughput for NFT transactions; b) average latency of transactions & CPU utilization rate of the transaction process.

messages several times. The average elapsed time spent per mapping is 0.45ms and 0.47ms, respectively (much smaller than the average transaction latency of 17ms, and thus the verification time is negligible).

Generic Connector Results. Fig. 5 shows the results of our evaluation of throughput, latency, and CPU utilization rate for patent NFT transactions.

In Fig. 5a, we depict the average system throughput curves for 10,000 transactions. Overall, the peak throughput is approached when the number of transactions reaches 5,000, and then stabilizes. Where *intra-chain* denotes transactions within a single blockchain and *cross-chain* denotes transactions between users of heterogeneous blockchains. The results show that the maximum throughput of cross-chain is 727 transactions per second (tx/s) without the sharding scheme [13]. Intra-chain transaction throughput is on average 1.2x that of cross-chain as there is time-overhead for cross-chain transmission and verification. With the sharding scheme, the throughput is significantly improved to about 2.6x with four shardings, as sharding scales the network capacity linearly, but it also incurs some sharding consensus and management overhead.

In Fig. 5b, we evaluate the transaction latency and CPU utilization rate under different concurrent threads. To not lose generality, we perform the test under a cross-chain scenario with four shardings. Overall, the results show that the latency and CPU utilization rate stabilize when the number of transactions increases to 1000 and 6000, respectively. When the number of concurrent threads is 10, the stable latency is 7.5 ms and the average CPU utilization rate is 43%, respectively. As concurrency increases, the transaction latency increases due to taking up more computational resources. At 20, 40, and 80 concurrent threads, the stable latency is 13ms, 22ms, and 37ms, respectively, and the average CPU utilization rate is 52%, 60% and 64%, respectively.

Therefore, combined with the above experimental results, Generic-NFT can ensure the usability of the trading system in large-scale scenarios.

Application Environment Discussion. In Table I, we compare the features of the mainstream NFT platforms with Generic-NFT. We select the top 5 platforms based on the volume share of each marketplace as of March 1, 2023, according to the nftscan website [15]. After our survey, we discover that the existing platforms mainly support trading digital and virtual assets on Ethereum, such as ERC-721, ERC-1155, and other standard NFTs, and none of them support cross-chain trading. In contrast, our Generic-NFT supports not only the existing digital and virtual asset transactions, but also real-world physical asset transactions. Moreover, Generic-NFT supports cross-chain transactions on any Turing-complete blockchains.

TABLE I
COMPARISON WITH EXISTING NFT MARKETPLACES

Existing NFT marketplaces	Trading volume share	Types of transactions supported	Support cross-chain transactions	The underlying dependent blockchains
OpenSea	43.61%	Digital art, collectibles, music, video, domain names, virtual lands, game props and other virtual assets	No	Ethereum, Solana, Polygon, Klatyn, etc
LooksRare	32.43%	Same as above	No	Ethereum
X2Y2	9.41%	Same as above	No	Ethereum
Blur	4.98%	Same as above	No	Ethereum
Gem	3.77%	Same as above	No	ERC-20 token public blockchains
Generic-NFT (This work)	-	Physical assets and all the above-mentioned types of digital and virtual assets	Yes	Any Turing-complete public and consortium blockchains

VI. CONCLUSION

This paper introduces a generic NFT architecture, called Generic-NFT, that lowers the barriers to the evolution of Web3 towards a decentralized Internet of Everything vision. Specifically, the architecture leverages generic connectors as a bridge between physical assets and application services. In this architecture, the public can easily and freely map the value of physical assets, and developers can quickly customize NFT applications. It unifies heterogeneous physical assets into a complete value interconnection ecosystem, facilitating entity control and management in the physical world, enriching decentralized applications in the Web3 cyber world, and providing hybrid storage and universal cross-chain for flexible interoperability between the two worlds.

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