



Cross-Game Asset Interoperability with Dapp & NFTs

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Abstract- Decentralized applications (DApps) have created new opportunities for asset management that become possible with blockchain technology combined with smart contracts. The " DApp Smart Fund Manager's " presents a decentralized platform which enables users to buy tokens from DApps while making shopping selections from inventory items together with automated NFT transfer capabilities. Through this protocol users can move digital assets with security between different parties with blockchain-based traceability and security measures intact. This technology finds important gaming use with gamers who transfer various skins across different games connected through decentralized systems. Game developers now have options to build shared ecosystems alongside users receiving better flexibility through blockchain-based cross-game asset transfer functionality.

Keywords- Blockchain Technology, Decentralized Applications (DApps), ERC-721 Token Standard, Digital Asset Trading, Interoperability Mechanism, Asset Transfer, Cross-Game Interoperability Smart Contracts..

I. INTRODUCTION

Due to its decentralized, transparent, and safe solutions, blockchain technology has completely transformed a number of industries. Decentralized applications (DApps) are one of the most important areas in which blockchain technology is being used. which leverage smart contracts to facilitate secure transactions and asset management. The gaming industry, in particular, has witnessed a surge in the adoption of blockchain- based solutions, enabling players to truly own their in-game assets and trade them across different platforms.

The conventional gaming domain operates on centralized models that impose limitations on digital assets in the form of skins, weapons, and virtual currency to a single gaming environment. Remains locked away inside the game environment, whatever items are bought in the games; this prevents their transfer to any other environments at all. Features like noninteroperability limit the potential value of in- game purchases and result in an extremely broken user experience. Where once central management had control of such assets, other factors intervened: security breaches and uncertainties of true ownership over game assets when access is suddenly cut off or policies changed by the server. This research delineates the creation of a "DApp Smart Fund Manager," a decentralized platform that offers seamless asset management within blockchain gaming ecosystems to deal with those challenges. The platform works with Ethereum's ERC-721 token standard, assuring the unique, non-fungible ownership of in-game assets. Leveraging smart contracts, players are able to buy, keep, and transfer digital items safely in a decentralized environment.



The proposed system permits the user to log in using their DeFi account and acquire different digital assets, such as gun skins, clothing, and virtual currency. Since all these assets are owned in a unique digital way, they can be used in any game that the company will develop.

Therein lies the core innovation of this platform: the ability to enable cross-game asset interoperability. Whereas in traditional gaming systems the utility of an asset is confined to a single game, the DApp Smart Fund Manager allows the digital assets to retain their usability and utility in games that share similar mechanics. This creates an enhanced gaming experience by the player, while exposing developers to new avenues of monetization based on the shared in-game economy theme. This research has implications beyond gaming, and it also covers broader implications connected to decentralized asset management. Blockchain technology serves in a way of tracking in-game assets by strengthening/fortifying security, removing the occurrence of counterfeiting, and naturally creating transparency during transactions among parties. Alongside that, the automation of the smart contract brings a substantial reduction in the reliance on intermediaries in transactions, ultimately leading to a cost-effective and less trust-dependent transaction.

This document follows a specific structure where Section II analyzes research about decentralized asset management and blockchain gaming. The Section III describes proposed system architecture and demonstrates the DApp Smart Fund Manager's design layout and functional features. The technological stack and key security aspects of implementation receive attention in Section IV of the document. The study examines system performance through experimental analysis that is reported in Section V. While Section VII addresses potential avenues for future research, Section VI focuses on obstacles and constraints. The paper concludes and summarizes its key findings together with its major contributions in Section VIII.

II. RELATED WORK

Scientific research has thoroughly investigated blockchain technology across supply chain management and gaming and banking sectors. The gaming industry experiences regular research about blockchain technology alongside its impact on decentralized asset management as well as non-fungible tokens (NFTs).

The implementation of decentralized asset ownership has been tried through multiple blockchain gaming platforms which currently exist. The gaming sector saw the inception of NFTs through CryptoKitties which enabled users to acquire exclusive digital cats while they could breed and exchange them with others in the platform. The implementation of blockchain technology for digital asset ownership revealed its potential during this project although scalability problems existed along with limited cross-game compatibility.

Cross-game interoperability. Blockchain-based economies were also introduced on Axie Infinity and Decentraland platforms which enabled users to buy, trade and utilize NFTs.

These platforms exist internally due to their own rules that prevent users from exchanging assets between various gaming zones.

1. Cross-Game Interoperability

The development of research about cross-game interoperability remains at its initial phase. Various research investigations introduce blockchain asset registries to maintain ownership records on the blockchain while enabling assets to function across different video games. Game developers need to



implement standardized frameworks for asset integration when they want to establish interoperability between different games.

2. NFT Standards and Their Limitations

The current blockchain standards ERC-721 and ERC-1155 enable NFT creation procedures as well as NFT transfer functions yet fail to ensure natural integration between different games. These ownership standards succeed in granting digital uniqueness but they fail to provide universal cross-platform linking standards.

3. Scalability and Cost Challenges

The main technical barrier facing blockchain gaming involves dealing with high transaction fees together with limited processing capacity. Players face high fees when using the Ethereum-based Ethereum elevate the cost of small in-game trades to point where new users find the platform less accessible. Layer 2 solutions including Polygon and Immutable X were created to tackle these issues because they offer lower costs with faster processing capabilities. Delegating gaming system adoption to these interoperability solutions produces inconsistent implementation across different gaming networks that fails to deliver global uniformity.

Research investigations have analyzed the key obstacles affecting blockchain gaming along with its ability to scale and user costs and interface limitations. Ethereum users continue to face high gas fees as an ongoing issue that drove the creation of Polygon and Immutable X as Layer 2 solutions to minimize expenses and boost transaction performance. The advancements enhance accessibility in blockchain gaming yet they do not completely solve the problem of moving assets between different gaming platforms.

The field of blockchain application for ownership in games has been proven but developers still need effective solutions to establish seamless platform-to-platform integration. A decentralized platform serves as the main focus of this investigation to provide easy cross-game assets transfer capabilities between compatible systems. The DApp Smart Fund Manager develops existing work through its implementation of the novel design unites NFT ownership control with smart contracts to create an unobstructed gaming environment for developers and players to interact without friction.

III. PROPOSED SYSTEM

The "DApp Smart Fund Manager" system employs blockchain technology to create a new approach for handling and utilizing game assets. This section describes the architecture structure along with the design of smart contracts and the system that enables interoperability between assets in order to enable smooth asset management and cross-game capabilities.

1. System Architecture

The DApp Smart Fund Manager relies on an architectural design based on decentralized principles that unite blockchain systems with gaming environments. Ethereum blockchain functions as the foundation platform that provides secure transaction management while delivering transparency as well as data immutability. The system comprises different crucial components:

User Interface (UI): The platform's user interface presents itself as users' principal means to interact with its available functions. Through decentralized finance accounts users gain system access to explore their assets and control their ownership of owned items. The UI development adopts intuitive layouts with easy access for users who range from newbies to seasoned experts to provide them with a seamless experience



The central blockchain feature executes smart contracts while it sustains the decentralized ledger functions. Every asset purchase and asset transfer gets recorded through the system for building transparent and protected transaction records. Ethereum is preferred as the blockchain platform thanks to its vast adoption rates and smart contract support yet upcoming versions might look into different blockchains for improved scalability.



Fig1: Cross-Game utilization flowchart

Game Integration Module: This module facilitates connection between the DApp and games built by the same company. The platform solution provides compatibility for integrating assets purchased through its platform into a range of gaming environments. The module enables standard APIs together with asset registries to maintain compatibility between different games.

Asset Management System: This system handles all operations regarding digital asset storage retrieval and transfer functions. The ERC-721 token standard serves this system to represent distinctive in-game objects while providing users with proof that they own these non- interchangeable assets. The asset management system enables users to build and control metadata about each asset after defining its functionalities and attributes.

2. Smart Contract Design

A crucial element of DApp Smart Fund Manager exists within its smart contract design because it facilitates trustless automated transactions. Through smart contracts users can create NFTs and handle their transfer and management functions including cross-game network exchanges. The smart contract design contains important capabilities including:

- **Minting and Ownership:** Smart contracts serve two functions through ownership and minting facilities by creating new NFT representations for in-game assets. Digital tokens receive their own distinctive reference code together with metadata during the assignment process. The blockchain preserves records of these tokens which enables owners to demonstrate their possessions through authenticated documentation.
- **Transfer and Trading:** The smart contracts enable peer-to-peer in-game asset exchanges through their system that boosts NFT trade capabilities. Transactions linked to these agreements meet security requirements while requiring developers to pay set fees or royalties.
- **Interoperability Logic:** The smart contracts implement interoperability logic that enables users to exchange assets between different video games. Users can verify assets function in different games and maintain their market value when developers establish compatibility among various games through this system.



The interoperability logic system enables developers to create asset integration parameters.

Asset Interoperability Mechanism

The DApp Smart Fund Manager achieves its core innovation through the asset interoperability mechanism to let users move their digital assets between different games. The asset interoperability system combines standardized asset registries and smart contract logic as well as game integration specifications to operate.

- Standard Asset Registries let users store metadata and compatibility information about each NFT on the platform. The registries operate as standard storage systems which let different games identify and work with the same assets when developers maintain established standards.
- The interoperability system maintains asset usefulness and market value when players move their assets between games that share identical playing mechanics. The standardization process applies common functionality requirements to assets so they work without obstacles across different game systems.
- Game developers need to work together for achieving successful implementation of cross-game interoperability. Through its developer resources the platform enables seamless integration of games with the DApp so assets can be used by all participating gaming systems. The cultural partnerships enable a combined virtual economic system that benefits all game stakeholders.

The proposed architecture along with smart contracts and interoperability system creates a decentralized gaming platform which delivers genuine asset ownership together with cross- game usability. By using this innovative approach gamers gain new potential interaction channels alongside business revenue growth that exceeds standard gaming systems.

IV. IMPLEMENTATION DETAILS

The execution of the DApp Smart Fund Manager rests on three main components including its selected technology stack and streamlined platform operation alongside its secure features. This part explores the critical components which enable the platform operations through its technical base.

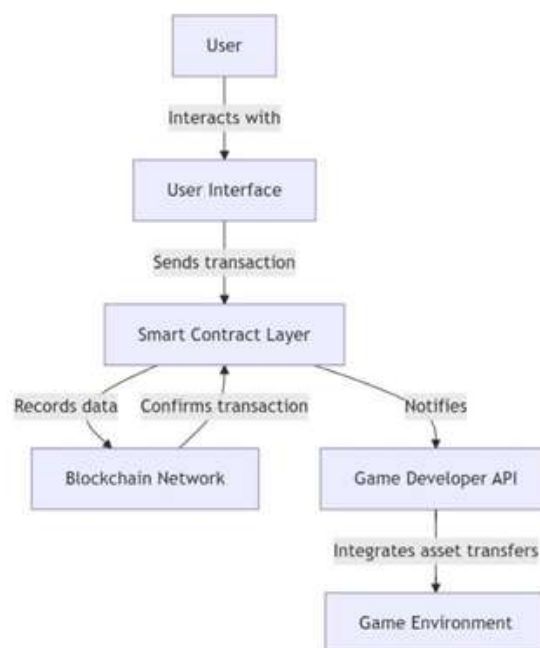


Fig 2. System Architecture Flowchart



1. Technology Stack

The technology stack for the DApp Smart Fund Manager is designed to harness the capabilities of blockchain technology while ensuring scalability, security, and user accessibility. The primary components include:

The application utilizes the Ethereum blockchain because it functions as its underlying core infrastructure. utilized as the core infrastructure, providing a A decentralized and secure environment based on smart exists for the execution of contracts within the Ethereum blockchain. contracts and managing NFTs. Ethereum's established

The ERC-721 standard develops from Ethereum's extensive ecosystem together with its support for this standard which makes it fitting for this application. a suitable choice for this application. The application makes use of Solidity as its smart contract programming language. Smart contracts are developed on the platform to manage NFT creation processes alongside their transfers and management functions. transfer, and management of NFTs. Solidity's compatibility with the Ethereum Virtual Machine (EVM) The platform enables quick secure execution of contracts.

User interface development for the system uses the Front-End Framework. The application implements React as its base framework to develop its web user interface. The platform employs React to build web applications which adapt to user needs. React's component-based architecture facilitates a Users achieve a complete interface which results in effortless platform navigation. with the platform. Wallet Integration: Integration with popular MetaMask serves as one of the popular cryptocurrency wallets which users can integrate with the platform.

Users can access their DeFi accounts to perform operations within the DApp through the platform. accounts. This integration ensures secure authentication and transaction signing. Node.js functions as the system backend platform for the project. development, providing a scalable and efficient The technology provides a framework which allows users to handle API requests together with API management capabilities. interactions with the blockchain. Express.js, a web Node.js uses Express as its application framework to construct The backend uses RESTful APIs which enable frontend- backend communication through the blockchain. front- end and the blockchain. Decentralized Storage:

IPFS (InterPlanetary File The platform makes use of IPFS (InterPlanetary File System) to keep record of asset metadata along with other non-sensitive data. The system ensures data distribution through secure information while providing resistance against failures. The system follows the Decentralized structure by building up resilience throughout its framework..

2. Platform Workflow

The Platform users have access to a seamless and intuitive experience for users, from asset acquisition to cross-game utilization. Key steps in the workflow include: User Authentication enables people to access the platform through Users authenticate to their DeFi accounts by establishing wallet connection procedures.

This process People need to join their wallet and sign authorization messages before accessing the platform. Users must authenticate then obtain entry to the platform features through their login process. features. Asset Acquisition: Users browse available in-game assets through the platform's marketplace. They can The system enables users to exchange cryptocurrency funds when they buy assets through built-in transaction capabilities.



Smart contracts through the platform handle secure payment transactions between users by using blockchain protocols. transparent exchanges. After acquisition all assets get stored within the user's wallet as ERC-721 tokens. Users can view, Users can manage all their platform-based assets through this platform's interface. Through the platform interface users execute all activities that the system records as blockchain transactions. transparency.

Depending on specific criteria, graphs displaying the benefits of Terraform-based migration show a 1 to 10 range. Terraform shows infrastructure management and security compliance ability, thus it provides best grades for security, CI/CD integration, and automation. Terraform makes good low cloud cost and resource management tool by using three qualities: scalability, cost optimization, and version control; these help to get strong evaluations. Changing providers calls for fresh installations, hence multi-cloud support is relatively limited. In terms of efficiency, tracking automation, and integration capacity to help to simplify cloud migration, Terraform usually excels.

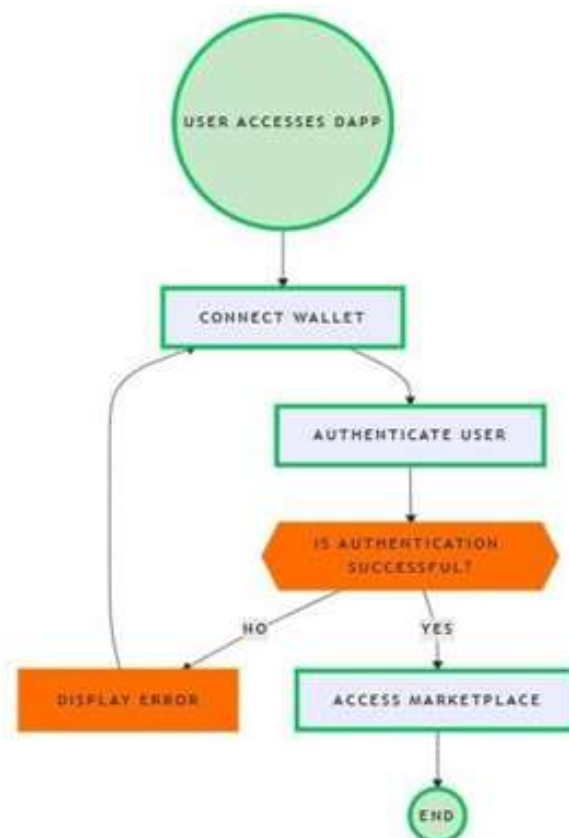


Fig 3.: User Authentication Flowchart

The game integration module of the platform enables users to use assets between games that support cross-game functionality. The platform supports users who need to move assets between different games maintaining their game functionality with increased gameplay value.

The platform includes a feature that allows its users to conduct NFT transactions with peer-to-peer capability, including sales, exchanges, or purchases. Users can execute transactions through smart contracts while smart contracts ensure security protocols and pre-defined rules remain in place.



3. Security Considerations

The implementation of the DApp Smart Fund Manager necessitates absolute security measures because digital assets have high value along with high sensitivity. The platform implements multiple safeguards that safeguard both user information and market assets.

The reliability and safety of our smart contracts receive examination through independent security company audits at every stage of execution.

User accounts experience minimal risk of unauthorized access because the platform relies on secure wallet authentication features provided by established wallet providers such as MetaMask to manage transactions and perform secure authentication.

Sensitive information along with user passwords and transaction details remains encrypted from the time of movement through networks and during periods of storage at rest.

The platform employs decentralized storage technology IPFS to distribute non-sensitive metadata and other information across multiple locations and thus protects them from manipulation or data loss.

The platform receives periodic security updates that handle both new security threats and existing vulnerabilities to preserve continuous dependability and safety.

V. RESULTS

The DApp Smart Fund Manager underwent evaluation via testing procedures and user feedback sessions because it aims to effectively handle game assets within multiple gaming platforms. The platform shows great potential for enhancing gaming experiences because it enables users to have real ownership together with digital asset interoperability.

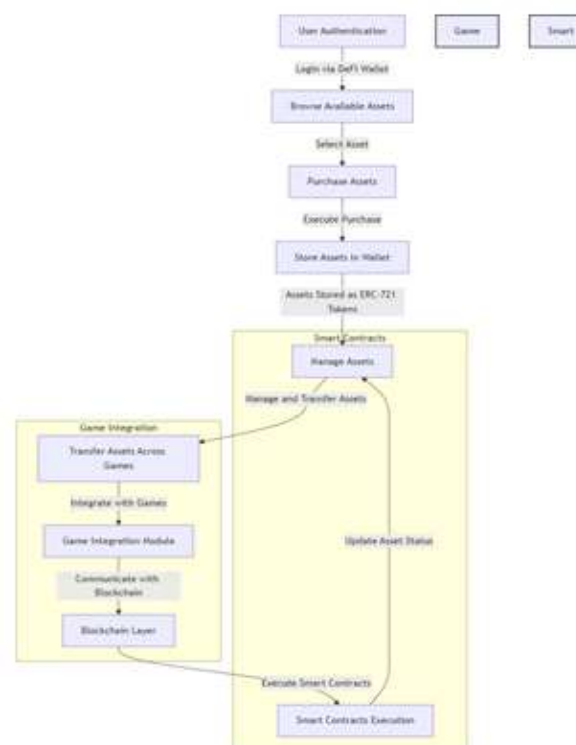


Fig 4: Asset Interoperability Workflow in Gaming DApps



1. User Experience and Engagement

Early users find pleasure with both the functionality and interface design of the platform they are using. Users congratulated the platform because it offered direct linking between DeFi accounts and digital asset supervision. The game asset transfer functionality received strong praise from users because it allowed them to maintain value consistency across different games. Users experience enhanced involvement through this feature which drives them to devote greater resources into the gaming framework because their assets extend beyond individual games.

2. Transaction Efficiency

The platform secured efficient asset transactions through its implementation of smart contracts. According to users the transaction process showed a seamless experience and absolute transparency because unauthorized incidents and fraud were not observed during any transaction. High gas fees became less of an issue because of Layer 2 solutions such as Polygon which improved accessibility for more users. User trust accumulates through this efficiency mechanism as the platform expands through growing user numbers.

3. Interoperability Success

The fundamental interoperability mechanism between games demonstrated success because the platform linked various games made by the same developer base. The platform showed successful interoperability because it maintained asset functionality across different games thus proving the transferability of assets. The remarkable success demonstrates how developers can build shared gaming economies capable of enabling assets to move across different environments that improve player satisfaction and create opportunities for developers.

Challenges and Limitations

The DApp Smart Fund Manager experience presents multiple obstacles and technical restrictions between deployment and implementation yet shows strong initial performance metrics.

Standardization and Adoption

The primary obstacle against asset integration across multiple games exists because of missing standardized asset-related frameworks throughout the gaming sector. The platform verified its ability to work together inside one company's system but full market acceptance requires support from various developers to create common industry standards. The various gameplay mechanics along with different game assets create an extensive challenge because specific customized solutions might be needed for each individual game.

Scalability Concerns

Platform scalability becomes a critical issue due to the increasing number of users who use the system. The Layer 2 solutions provide better performance compared to base blockchain protocols but the original blockchain network can experience slowdowns when the system hits peak usage demands. To maintain long-term operation the platform must demonstrate ability to execute fast and large-scale transactions without encountering performance problems.

Security Risks

Strong security features on the platform do not eliminate all risks since cyber threats continuously evolve. The prevention of possible dangers like phishing attacks along with wallet security breaches and smart contract vulnerabilities requires constant monitoring and preventative measures



Future Work

The DApp Smart Fund Manager presents extensive opportunity to study and develop its features while addressing existing operational problems.

Expanding Interoperability

The platform plans future enhancements to expand compatibility by integrating different development studio games and multiple gaming genres. The expansion process requires industrial stakeholders to work together on creating standard frameworks which specify asset integration procedures. Partnering with blockchain consortia and gaming alliances would support both standardization and broader adoption of the platform.

Enhancing User Experience

User experience improvement continues as the top priority for the platform's developers who plan to develop interfaces that will improve asset operations while introducing new functionality. The system will adapt to changing customer needs through a feedback-driven development system.

Advanced Security Measures

Research will explore enhanced security features by investigating how multi-signature wallets combined with decentralized identity solutions would protect user accounts and assets. The security plan for the platform will execute updates combined with regular security audits as its foundation.

Exploring New Use Cases

Decentralized asset management features from the platform provide potential applications for virtual real estate and digital art collection and virtual assets preserving sectors which extend past gaming. Technical investigations of new use cases will both generate new revenue streams and attract a wider user base to the platform

VI. CONCLUSION

The DApp Smart Fund Manager represents an essential breakthrough through blockchain technology due to its provision of authentic ownership control and cross-game functionality for in-game assets. The platform successfully demonstrates its abilities to transfer assets between different games and develop a shared economic system through its existing deployment. Several challenges remain despite the platform's advances but its innovative approach coupled with positive performance marks the beginning of improved development and greater adoption of blockchain technology

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