NFT-based Asset Management System

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Abstract— **There are billions of houses, businesses, and lands in the world, and we can prove the ownership of these assets with title deeds prepared by government offices. In the purchase and sale transactions of these titled assets, it is necessary to go through long and complex possess, and the actions that need to be taken do not end here. The asset must also be insured and paid regularly for insurance, tax, and some subscriptions like electricity, water, natural gas, etc. This study aims to create a blockchain-based asset management system that uses NFTs (non-fungible tokens), smart contracts, and the Ethereum network.**

Keywords—blockchain, security, NFT, smart contract

I. INTRODUCTION

Non Fungible Tokens (NFTs) represent ownership of digital or non-digital objects, and they are managed by a blockchain network [1]. Nowadays, one of the most used blockchain networks is the Ethereum network. On this network, you can mint NFTs, you can deploy smart contracts which means that you can run programs in the Ethereum network. This network has been controlled and sustained by a community, which means that you don't need to trust an individual as long as the community has enough people.

There are billions of houses, businesses, and lands in the world, and we can prove the ownership of these assets with title deeds prepared by government offices. In the purchase and sale transactions of these titled assets, it is necessary to go to the banks, notary public, title deed offices authorized for title deed transactions, and even to the municipal buildings after the transaction and carry out long and complex transactions. In addition, since these transactions must be carried out during working hours, employees must either take leave from the workplace during these hours, or they must find someone in their place to replace and continue the transactions through him. Of course, in addition to this, a different fee and expense amount are incurred for each transaction.

Unfortunately, the actions that need to be taken do not end here. This property must also be insured and paid regularly for insurance and tax. In addition to these transactions, the person using the asset (can be the owner or tenant) must have internet, electricity, water, and natural gas subscriptions and regularly pay these subscriptions by adding the subscription fee (if the tenant is also the rental fee).

In this study, we designed an asset management system that uses the features of blockchain technology, which is popular and used today, facilitating post-purchase transactions, and facilitating the management of invoices that must be paid regularly.

Also, we want to mention that we only used this system as a real-life asset management system. But the usage of the system can be applied to any subscription system, especially in the concept of the metaverse.

II. FUNDAMENTALS

In this section, we briefly introduce some of the fundamentals that are going to be used in the system proposal:

A. Blockchain

As the name suggests, a blockchain is a linked list of records, which is also called blocks, that holds valuable information, and the linking process is secured by using cryptography [2][3]. Each record or block contains a hash value of its previous record. If some node tries to miniplate an old record, the network can detect it using these hash values. This feature gives Tamper-proof characteristics to the blockchain.

One of the other characteristics of a blockchain is decentralization. There are two types of blockchain networks:

- Permissionless blockchain: This network is open for anyone to participate and interact. It is completely decentralized. One advantage to a permissioned blockchain is that each node is trusted which means there is no need for access control [4].

- Permissioned blockchain: These blockchain networks are controlled by a list of trusted nodes. This type of blockchain needs an access control layer for guarding the network against unknown parties [5].

B. Ethereum

Ethereum is a public permissionless blockchain network that supports smart contract functionality. It was designed in 2013 by Vitalik Buterin [6]. Ethereum allows individuals to build an app on the network which is decentralized. Ethereum also supports the creation of NFTs.

C. Smart Contract

Smart contacts are computer programs that can be run without any human interactions [7]. One of the key features of smart contracts is that there is no need to trust a third party to be an intermediary between sides.

D. Non-Fungible Tokens

Non Fungible Tokens (NFTs) represent ownership of digital or non-digital objects, and they are managed by a blockchain network. Minting is the name of the creating process of NFTs, and anyone can mint NFTs without any coding skills [8]. NFTs generally contain an identifier and references to digital objects, that could be audio, video, or an image. Also, NFTs can be used to represent ownership of an asset.

E. ERC721

On the Ethereum network, with the use of the standard named ERC-721, it was made possible to prove ownership of digital assets [9]. This inheritable standard allows users to track the ownership of NFTs.

F. Wallet

Wallets or cryptocurrency wallets are used to store public and private keys which are used for transactions [10].

III. RELATED WORKS

Karamitsos presented a detailed smart contract design for a real estate area, examined a use case for residential and business buildings' rental, and demonstrated this decentralized application (DApp) using the Ethereum network and solidity programming language [11].

Glaser found that using the layered approach for technical decisions would provide more diverse applications for Blockchain technology beyond single cryptocurrency exchanges like Bitcoin [12].

Conversely, Atzori argues that current blockchain techniques are generally not suitable for IoT applications because IoT devices may need to operate with low computational capacity or very low power, and the verification time is also very low [13]. The main concern for blockchain technology is efficiency. Blockchain requires a certain verification process to create a new transaction record, which results in a significant confirmation time delay and a waste of powerful computing resources.

Zyskind et al. proposed a lightweight decentralized blockchain data management architecture to protect personal data and enable users to own and control their data [14]. The proposed method improves efficiency by using off-chain data storage.

IV. SYSTEM PROPOSAL

In this section, we present the system, and the system actors and each uses cases with figures.

A. System Actors

In our system six different roles are in the life cycle:

Blockchain Network: we used the Ethereum blockchain network to build and deploy our decentralized app.

Government: The creator who is responsible for deploying the system and minting asset NFTs

Owner: It represents a wallet whose owner is also the owner of an asset.

Asset Smart Contract: It is a smart contract that mints asset NFTs.

Subscription Smart Contract: It is a smart contract that is responsible to manage subscriptions.

Company: A wallet whose owner is the company that an asset owner wishes to subscribe to.

B. Deployment of the System on the blockchain and minting the first NFT

The deployment process requires actors to be completed. These actors are Government, blockchain network, asset smart contract, and subscription smart contract. In this case, we assume that government wants to deploy the system and after that, the asset in real life has been created and the government wanted to issue the asset to an individual. This process can be described as follows and shown in Figure 1.

1. The government successfully deploys the asset smart contract.

2. The government successfully deploys the subscription smart contract.

3. The government sets the address of the asset smart contract to the subscription smart contract so that the asset can interact with the subscription contract.

4. The government sets the address of the subscribe smart contract to the asset smart contract so that the subscriber can interact with the asset contract.

5. The government mints the first asset NFT for the owner.

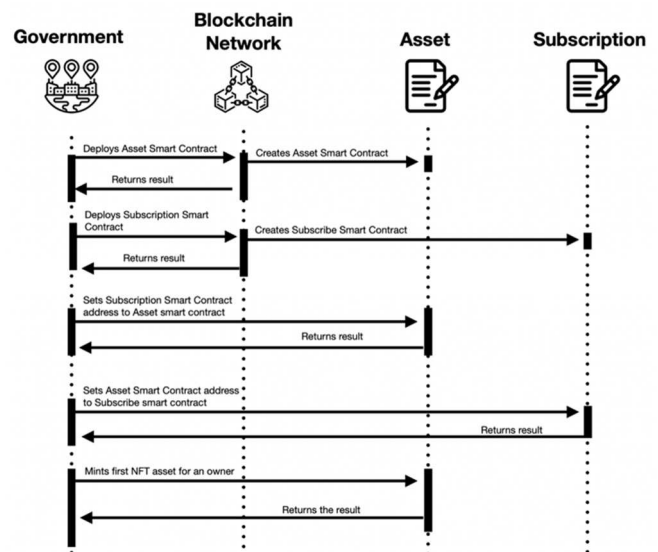6. An Id assigns to the asset with the owner's wallet address.

Figure 1. Deployment of the proposed system

C. Application for a subscription process

Application for a subscription process requires three actors to be completed. These actors are the owner, the asset smart contract, and the subscription smart contract. In this case, the owner of the asset, which is minted by the government, wants to subscribe to a company to be able to get its services. Authorization controls are made at the beginning of the process by the asset smart contract to assure that only the

owner of the asset can apply for a subscription and by the subscribe smart contract to assure that the request came from the asset contract. This process can be described as follows and shown in Figure 2.

1. The owner calls a function on the asset smart contract to apply for a subscription using its asset id and company wallet address.

2. The asset smart contract authenticates the owner.

3. The asset smart contract calls another method from the subscription smart contract.

4. The subscription smart contract authenticates to the asset smart contract.

5. The subscription smart contract successfully creates a new subscription application object using asset id and company address.
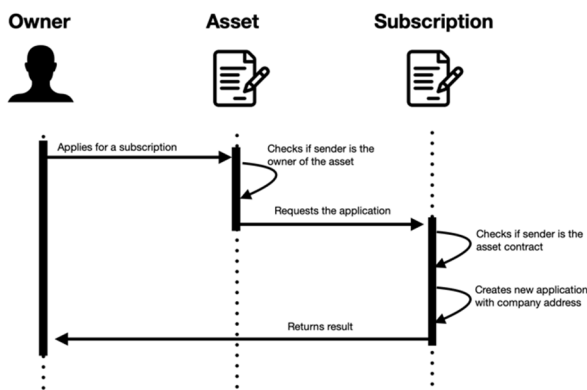

Figure 2. Application for a subscription process

D. *Approving subscription application process*

Approving a subscription application process requires two actors to be completed. These actors are the company and the subscription smart contract. In this case, we assume that a subscription application is made for an asset to the company. This process can be described as follows and shown in Figure 3.
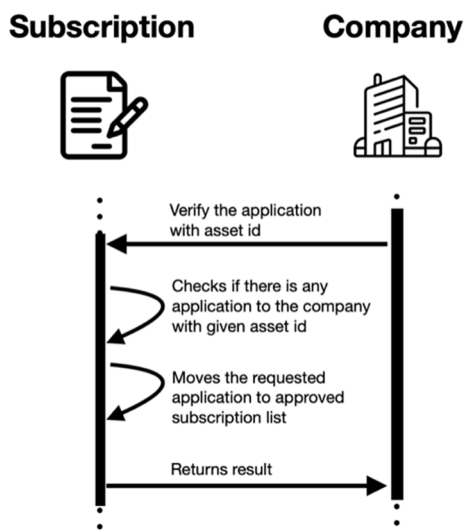

Figure 3. Approving a subscription application process

1. The company calls to approve the subscription function by using asset id from the subscription smart contract.

2. The subscription smart contract finds a subscription application, which is made by the owner, and moves the subscription application to an active subscription.

E. *Company billing process*

The company billing process requires two actors to be completed. These actors are the company and the subscription smart contract. In this case, we assume that there is already an active subscription. This process can be described as follows and shown in Figure 4.
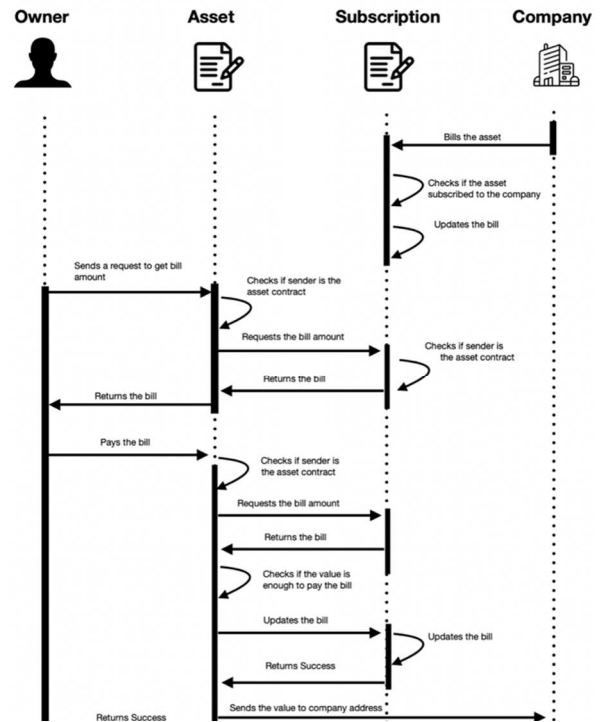

Figure 4. Paying bill process

1. The company calls the billing function with asset id and bill amount.

2. The subscription smart contract finds the active subscription using the asset id and the company address.

3. The subscription smart contract updates the subscription bill.

Paying bill process requires three actors to be completed. These actors are the owner, the asset smart contract, and the subscription smart contract. In this case, we assume that there is already an active subscription, and it has been billed by the company. This process can be described as follows and shown in Figure 4.

1. The owner calls to get the bill function with asset id and company address from the asset smart contract.

2. The asset smart contract authenticates the owner.

3. The asset smart contract calls get bill method with asset id and company address from the subscription smart contract.

4. The subscribe smart contract authenticates the asset smart contract.

5. The subscribe smart contract finds the subscription and returns its bill amount.

6. The asset smart contract returns the bill amount to the owner.

7. The owner calls a payable function with asset id, company address, and bill amount value from the asset smart contract.

8. The asset smart contract authenticates the owner.

9. The asset smart contract calls get bill method with asset id and company address from the subscription smart contract.

10. The subscribe smart contract authenticates the asset smart contract.

11. The subscribe smart contract finds the subscription and returns its bill amount.

12. The asset smart contract confirms the value is enough to pay the bill.

13. The asset smart contract calls to update the bill function from the smart contract to decrease paid bills.

14. The subscribe smart contract authenticates the asset smart contract.

15. The subscribe smart contract successfully updates the bill and returns success.

16. The asset smart contract sends paid bill value to the company.

17. The asset smart contract returns success to the owner

F. Application for an unsubscription process

Application for an unsubscription process requires three actors to be completed. These actors are the owner, the asset smart contract, and the subscription smart contract. In this case, the owner of the asset, which is minted by the government, wants to unsubscribe to a company. Authorization controls are made at the beginning of the process by the asset smart contract to assure that only the owner of the asset can apply for an unsubscription and by the subscribe smart contract to assure that the request came from the asset contract. This process can be described as follows and shown in Figure 5.
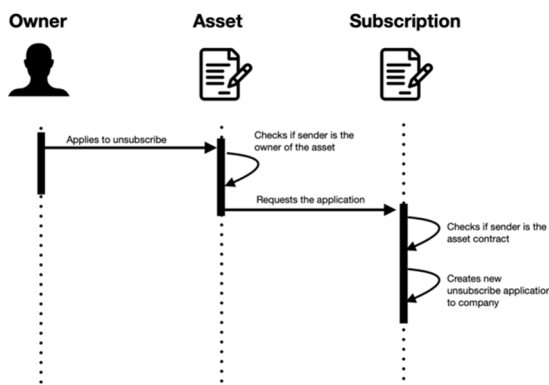
Figure 5. Application for an unsubscription process

1. The owner calls a function on the asset smart contract to apply for an unsubscription using its asset id and company wallet address.

2. The asset smart contract authenticates the owner.

3. The asset smart contract calls another method from the subscription smart contract.

4. The subscription smart contract authenticates to the asset smart contract.

5. The subscription smart contract successfully creates a new unsubscription application object using asset id and company address.

G. Approving unsubscription application process

Approving an unsubscription application process requires two actors to be completed. These actors are the company and the subscription smart contract. In this case, we assume that an unsubscription application is already made for an asset to the company. This process can be described as follows and shown in Figure 6.
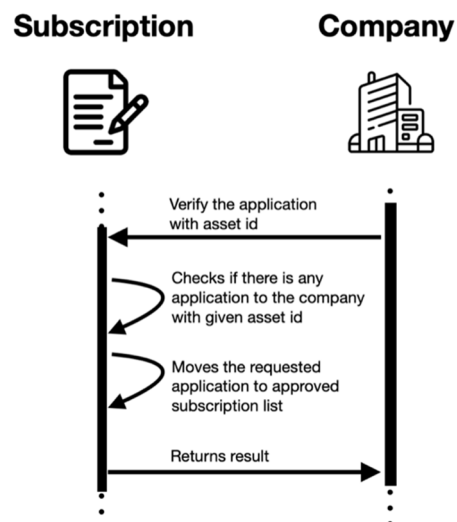
Figure 6. Approving an unsubscription application process

1. The company calls to approve the unsubscription function by using asset id from the subscription smart contract.

2. The subscription smart contract finds the unsubscription application, which is made by the owner and removes the active subscription application and the unsubscription application of the asset.

V. RESULT AND CONCLUSION

The proposed system uses blockchain technology and each asset is represented by an NFT. With this system, all subscriptions are managed using a single NFT, in the application progress there is no need to sign a physical contract, and also selling and buying process of an asset is ownership of an asset made easy by using NFT deeds.

Even though the proposed system helps the owner manage their assets, it also brings some obligations and disadvantages. Each NFT needs to be owned by the owner

and the owners must own a wallet on the used blockchain network. In case of losing access to the wallet, the asset cannot be managed. This problem might be solved by authentication made by the government, but access to the wallets needs to be managed by the government as well.

Another issue with the proposed system is transferring the asset to another wallet. In order to transfer an asset, there should not be any subscriptions except a government subscription for asset tax.

The renting system might be implemented in the proposed system to increase visibility by the government. In the current renting system, most of the rental income cannot be taxed due to a lack of visibility by the government.

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