A16 Blockchain Q2 Project Proposal

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Abstract

This report outlines our investigation and plans for design and implementation of RE transactions on a Blockchain. We start by outlining the challenges and opportunities for migration of RE transactions onto blockchain in Section 1: Problem Statement, followed by an preview of Project Deliverables (Section 2: Project Deliverables) followed by architectural design in Section 3: Architectural Design. We conclude by outlining the Section 4: Implementation Plan and the potential problems with solutions.

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1 Problem statement

A real-estate (RE) transaction involved transfer of property rights associated with an immovable asset, a plot of land and/or constructed building. Such a transfer involves transfer of legal "title" to the immovable asset ("property") as well as exchange of monetary funds from buyer to seller, usually via intermediary parties. The property transaction and title management industry grapples with a myriad of challenges that hinder efficiency and transparency. Fragmented data ecosystems and reliance on legacy systems contribute to scattered information and interoperability issues. Security vulnerabilities and fraud risks persist due to the reliance on traditional paper-based documentation. Navigating complex and evolving regulatory frameworks poses a considerable challenge, as does the limited accessibility to accurate property information. Cumbersome title transfer procedures, lack of transaction transparency, and resistance to technological adoption further compound these challenges. Overcoming scalability issues in blockchain implementation, addressing the complexity of mortgage servicing, and fostering industry-wide collaboration are essential for reshaping and enhancing practices within this sector. In the current real estate landscape, transactions are often burdened by centralized processes, involving intermediaries and paperwork, leading to inefficiencies and increased costs. Our goal is to address these challenges by creating a decentralized network on the Ethereum blockchain. Through the use of Solidity, IPFS, and Hardhat for backend development and a frontend website built with React.js, we aim to streamline real estate transactions, eliminating the need for traditional intermediaries and providing a more efficient, transparent, and cost-effective solution for participants in the real estate market.

Furthermore, the elimination of real estate agents, mortgage servicers, and title search companies from the equation not only simplifies the process but also reduces the associated fees and time, making real estate transactions more accessible to a broader demographic.

Participants in the network will have direct control over their transactions, fostering a peer-to-peer environment that is both secure and efficient.

While starting off, we would be only onboarding and listing residential properties with a gradual shift to include commercial and industrial properties as well as creating rental listings. Having the token on the blockchain will also make it easier to lend, or invest in real estate by indirect means having a fixed rate of return. We would also like to incorporate peer-to-peer lending, which would work similarly to traditional mortgage financing but instead of a bank, it could be any individual.

Thus a RE transaction consists of multiple sub-transactions which are provided by different service vendors leading to inefficiencies, costs and delays in the process. In particular:

1. **Vulnerability to Loss, Fraud, and Mismanagement**

   The reliance on paper documentation exposes land titles to the risk of loss, fraud, and mismanagement. Previous attempts at addressing this issue have been limited by the lack of a secure and transparent system that ensures the integrity of land records. Our Quarter 2 Project aims to mitigate these vulnerabilities by introducing a blockchain-based system that provides a secure and immutable ledger for land title documentation.

   Immutability refers to the unalterable nature of data once it has been recorded on the blockchain. Immutability stands out as a fundamental characteristic of both Bitcoin and blockchain technology. It ensures that transactions recorded on the network are resistant to manipulation, replacement, or falsification by any entity [1]. This feature is crucial in the context of land title management, as it provides a ro-

bust defense against fraud and unauthorized alterations to property records. The immutability of Ethereum's blockchain adds a layer of trust and reliability to the land title management system, enhancing the overall integrity of recorded data.

2. **Lengthy and Costly Legal Procedures**

   The current process of property transfers and permits involves a multitude of lengthy and expensive legal procedures. In our Quarter 2 Project, we seek to optimize and automate these legal procedures through smart contracts on the Ethereum blockchain, thereby reducing the time and resources required for property transactions.

Transparency in the context of blockchain refers to the visibility of all transactions and data to all participants in the network. Ethereum achieves transparency through its distributed state machine, where each participant holds a copy of the Ethereum' state which holds not only all accounts and balances, but a machine state [2]. Every transaction, including changes to property ownership or land title information, is visible to all nodes in the network [2]. Smart contracts on the Ethereum blockchain, which can be utilized in land title management, contribute to transparency by executing predefined rules automatically and making the outcomes of those rules visible to all relevant parties. These contracts are self-executing and self-enforcing, providing a transparent and trustless environment for property-related transactions [3].

The transparency of Ethereum's blockchain is especially valuable in land title management, where multiple stakeholders, including property owners, bank entities, and potential buyers, can have real-time access to accurate and unambiguous information. This transparency reduces the risk of disputes, increases confidence in

property transactions, and streamlines the overall process of managing land titles.

3. **Limited accessibility**

   Limited accessibility to information within the property transaction and title management industry exacerbates challenges for various stakeholders. Stakeholders, including buyers, sellers, and financial institutions, often face obstacles in obtaining accurate and up-to-date property information. This lack of accessibility can impede transparent decision-making processes, leaving parties with incomplete or outdated data. Property details, transaction histories, and ownership records may not be readily available or easily accessible, leading to inefficiencies and delays in crucial decision-making processes. This limited access to information not only hampers the overall efficiency of property transactions but also creates an environment where stakeholders may have to rely on incomplete or unreliable data, potentially leading to suboptimal outcomes and increased uncertainty in the real estate market. Addressing this challenge involves developing solutions that enhance the availability, accuracy, and accessibility of property information, fostering a more informed and transparent ecosystem for all stakeholders involved in property transactions.

2 Project Deliverables

The final output of our project will be a website that users can interact with. The website will be similar to that of OpenSea's, a marketplace that facilitates the transactions of NFTs from user to user. For our purpose, we will be hosting a website to allow buyers and sellers to trade property in the form of ERC721 tokens. The website will aim to have the following features:

1. Allow users to log in and connect their wallet through Metamask for the Ethereum network.

2. Allow the users to search and navigate through a catalog of properties listed by other users.
3. Facilitate trading and communication between the buying and selling party.
4. Allow sellers to list their property by tokenizing it as an NFT token, all details of the property are filled in by the seller.
5. Allow buyers to confirm the property's validity and authenticity.
6. Allow for mortgage payments between the buyer, seller, and a third loaning party.
   (a) The seller will authenticate a transaction with the loaning party, in which the loaner will receive the property as a NFT token while the seller will receive the transaction amount in full.
   (b) The buyer will then enter a smart contract agreement with the loaning party, in which the buyer will receive a copy of the property token as proof of ownership and acts as an invoice of the financing agreement with the loaning party. Throughout the payments, the loaning party has full ownership of the real copy of the property token. Once the loan is fully paid off, then the copy of the property token is burned and the loaning party will transfer the real copy to the buyer, signifying that the transaction is complete and the buyer has full authority of the property.

   The final website will consist of three main pages. The first being the marketplace containing all the properties on sale, which users can browse through. The second page will allow users to upload their property onto the platform and mint their own NFT/collection. The third will be the user's profile, containing all the NFTs they currently own under their wallet address and a report of their transaction history. If possible, we would also like to integrate a chatting interface that allows users to negotiate deals amongst each other, however, that will come at a later priority, once the main foundation of the platform is set up.

3 Architectural Design

Based on our current architecture, we have the following process charts for the main actors in our app namely the potential buyer of a property, the potential seller of a property and potential investors or banks.

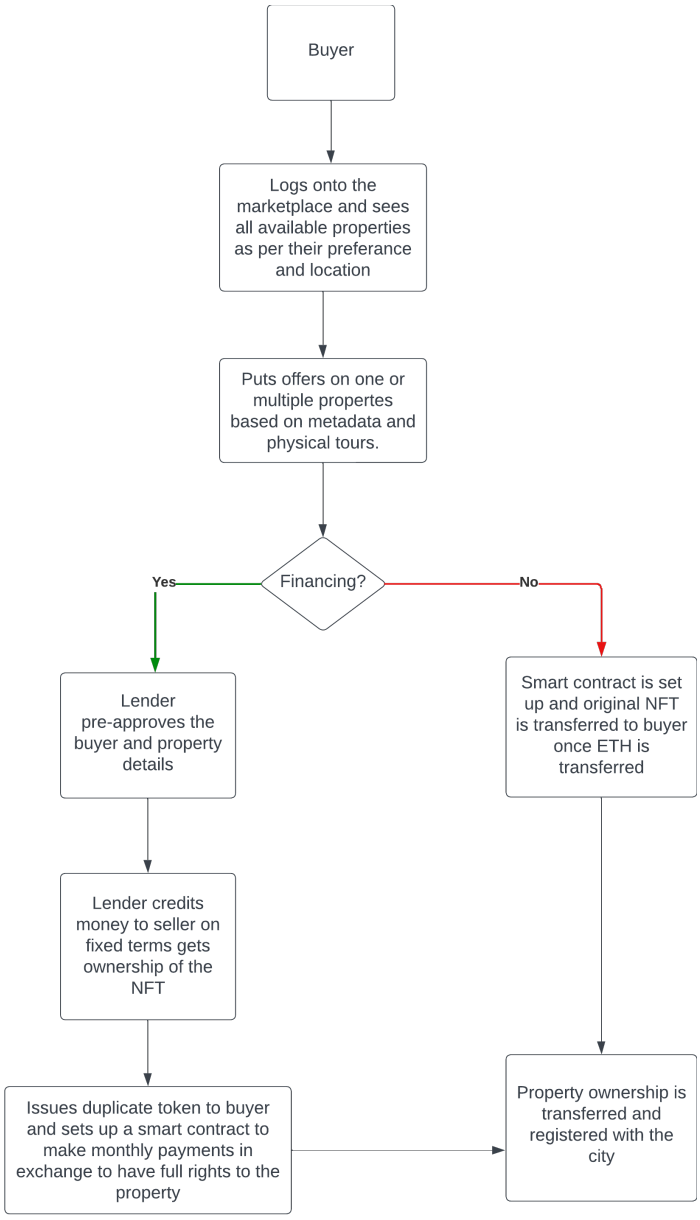
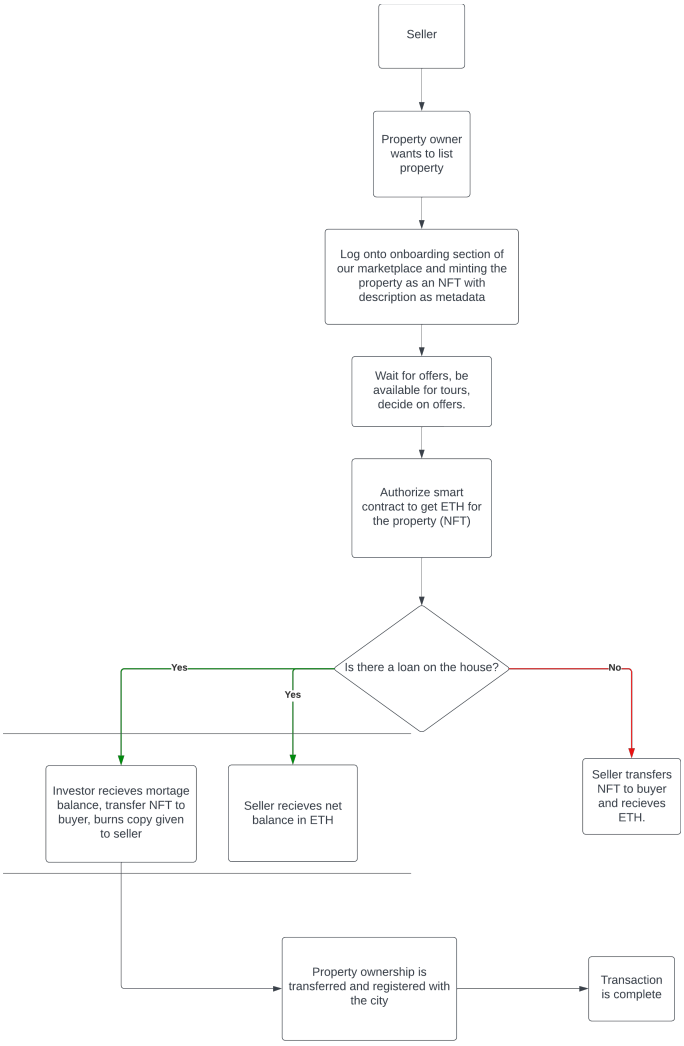
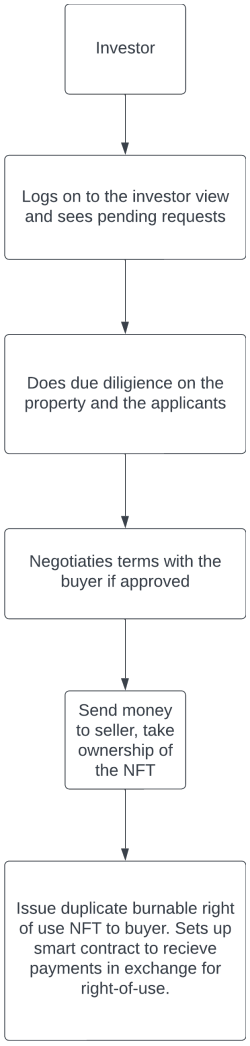


Figure 1: Process flow for potential buyer



(a) Process flow for seller



(b) Process flow for investor

Figure 2: Process charts for main actors

We currently plan to use the following data structure for a residential property -

Listing 1: Data Structure for Residential Property

```
// Define the Location struct
struct Location {
    string address; - to store the physical address of the property
    uint32 zipCode; - to store the zipcode of the property
    string city; - to store the city where the property is located
    string state; - to store the state where the property is located
};

// Define the PropertyFeatures struct
struct PropertyFeatures {
    uint16 squareFootage; - to store the square footage of the property
    uint16 bedrooms; - to store the number of bedrooms in the property
    uint16 bathrooms; - to store the number of bathrooms in the property
    uint16 parkingSpots;
    string additionalFeatures;
};

// Define the RealEstateInfo struct
struct RealEstateInfo {
    address owner; - to store the blockchain address of the owner
    Location location; - to access the struct defined above
    PropertyFeatures features; - to access the struct defined above
    uint32 price; - to store the list price
    string contactDetails; - to store the contacts of the seller
    string[] images; - to store the images of the property
```

```
    string notes; – to store any addiotnal notes
    uint256 apn; – Accessor Parcel Number given by the city
    bool forSale; – To get the listing status of the property
};
```

4 Implementation plan

We can describe a very brief overview of our implementation plan grouped based on the following modules:

1. **Seller Minting NFT**

   In this step, we implement the functionality to allow sellers to mint NFTs and publish them on the blockchain. We use the front-end of our application to gather property data from the seller and send that data to an API to publish it on the blockchain.

2. **Marketplace Backend**

   In this module, we implement the back-end of our marketplace where all the data is fetched from the blockchain, and based on location and other filters is displayed to anyone browsing on the front-end application.

3. **Seller to Buyer**

   In this step, we implement the initiation of smart contracts and transfer of the NFT from the seller to the buyer with an added intervention of the investor if financing is involved.

4. **Bank Financing**

   In this step, we implement the investor module where-in a buyer can apply for financing and potential investors can lend out money for a fixed term and interest rate.

5. **Verification**

   In the part of the app, before minting the NFT, we use the Accessors Parcel Num-

ber to verify the metadata of the property with the city's or county's public records and give the minting process an approval.

6. **Front-end frameworks and building web-app**

   In this step, we combine all of the modules discussed above and create a consumer facing website which compiles all the functionalities of our project.

4.1 Contingency Plans

4.1.1 Regulatory Compliance

Challenge: Real estate transactions are subject to diverse regulatory requirements across different cities, counties and states, making compliance complex.

Alternative: Seek with legal help to embed compliance rules within smart contracts. Take incremental steps in understanding each geopgraphical area before expanding our reach there.

4.1.2 Smart Contract Security

Challenge: Real estate is often the most expensive thing people own and consequenctly security has to be such that it is impossible to breach as well as hack into a smart contract. Developing secure smart contracts is crucial to prevent vulnerabilities and attacks.

Alternative: Involve blockchain cybersecurity experts along with only using in-house packages to reduce third party dependency and be vulnerable to cyberattacks if any dependencies go down.

4.1.3 User Adoption and Accessibility

Challenge: Blockchain is still considered to be risky and not mainstream by majority of the population. Building trust and ensuring widespread user adoption and accessibility for non-technical users can be challenging.

Alternative: Develop a user-friendly interface, provide clear instructions, and offer educational resources. Clearly highlight the pros and cons of Blockchain along with how our website is tackling the issues. Conduct pilot programs to gather feedback and improve usability.

4.1.4 Customer Support and Conflict Resolution

Challenge: Disputes may arise, and since it is a high-value transaction on the blockchain requiring a robust mechanism for verification and decentralized dispute resolution.

Alternative: Implement decentralized dispute resolution mechanisms using smart contracts or involve legal experts to perform human intervention. It is also imperative that smart contracts are updated periodically to ensure that they are up-to-date with any new regulations passed.

References

[1] Caner Taçoğlu, *Immutability*. https://academy.binance.com/en/glossary/immutability%7D

[2] Dragan Rakita, *Ethereum Virtual Machine (EVM)*. https://ethereum.org/en/developers/docs/evm/#from-ledger-to-state-machine

[3] Joshua, *Introduction to Daps*. https://ethereum.org/en/developers/docs/dapps/%7D