

Land Registration System Using Blockchain

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Abstract—In the traditional Land Registration system practiced in India, there exists a middle man (broker) who establishes a contact between the buyer and seller, for instance if an individual wants to buy or sell a property, the broker will create and assemble all the obligatory physical documents with regards to an agreement as a proof of property. Brokers will ensure that the land/property would be registered by an authorised government office where all the attributes are noted down in a ledger and thereafter the whole transaction and purchasement between the two parties takes place. In this scenario, there are chances of losing or tampering of the documents as anyone with certain powers can access or alter the papers easily which in turn threatens this concrete proof of land. Thus, this type of system as compared to our proposed system in which we make use of a smart contract to deal with the assets and transactions among the participants, is relatively time consuming, less secure and unsynchronized where activities including corruption and fraudulence might be associated during the execution of the required process. With an amalgam of inspection and analysis regarding the old accustomed way and considering that Blockchain has an increased transparency and integrity maintenance along with the portability factor, we put forward a blockchain based land registration system which provides a transparent, secured and decentralised method for execution of transactions between the participants by employing the concept of hyperledger.

Index Terms—Blockchain, Land, Hyperledger, land registration, secure

I. INTRODUCTION

Blockchain is an emerging platform for developing decentralised applications and data storage among the shared parties with all recorded transactions that have been executed through-out the process. Each and every transaction in the public ledger is verified using consensus protocols involving majority of the participants of the system. As the new data is emerging blocks are created and encrypted using hashing algorithms. Thus, the information entered once cannot be modified without consulting a legal administrator. Blockchain allows one to create a ledger of events, transactions and data, generated through various IT processes with strong cryptographic guarantees, that is distributed and replicated across the network for tamper resistance, immutability and verifiability. It is a distributed digital ledger that is open, shared, transparent and highly secured which means all the transactions or records processed are immutable and verifiable. As the name indicates, blockchain allows a block of data to grow as new blocks are appended to it, with each block containing transaction information stored in a specially designed data storage structure.

In this system, users would register on the portal and can take up the role of a buyer or seller accordingly. The seller needs to upload all requisite details whereas the buyer can then buy the lands on the portal that are verified by the smart contract. Further users can get deeds digitally which will be uploaded as a new block in the chain. In this way this proposed system does not involve any middleman and all transactions are directly dealt between the buyer and the seller. Transactions will be backed up in all legal servers of all the parties involved in a cryptographic format and the audit ability of transactions will be stronger now that they are associated with timestamps.

II. MOTIVATION

Digitalization and the development of new technologies is the strongest force of change in society. In the old accustomed system, if a user lost original physical agreements which acts as concrete proof of the ownership or if documents get altered or damaged then it is very difficult to navigate all the details in regards with the assets. Traditionally it takes a huge amount of time for verification of owner, land papers manually which in turn slows down the legitimate transactions. Another alarming concern is that of fraudulent activities including hampering, bribery, forgery or alteration carried out by middle agents in the process which results in lack of security.

We began to propound our idea of a blockchain based land registration system as an alternative to the traditional one by taking various factors into account. Proposed system will speed up the verification process of owner, land deeds and also accelerate a speedy recovery of data in case of disaster, cache all the changes done in a blockchain and ensure that no existing transactions are meddled with. Thus transactions will be more secure. Data of the owner and land is encrypted so that alteration of data will be avoided.

We advocate a decentralised system or peer to peer system which does not involve a middleman for making deeds and all the transactions are directly dealt between buyer and seller using digitally created and verified agreements. So this updated system can avoid fraudulent activities as blockchain uses hashing techniques and any alteration is recorded. All changes are stored in the next block so that no user is unaware of the current state of any asset and all transactions are stored in a blockchain with appropriate timestamps associated with them for strong auditability.

III. SCOPE

The Land registration system incorporating blockchain using blockchain provides features like registration of owner and land by uploading mandatory verified documents. After verification of the owner/land using smart contract using smart contract and consensus protocols implemented in the model, land can be put up for the sale and then assets will be visible to all the potential buyers. Simultaneously the sale revenue of the land including stamp duty, cost of the land as per the official criteria and registration fees is calculated automatically and the final selling cost of land is generated. After agreement between both the parties, purchase of land gets completed and transactions are recorded and added to the blockchain. Thus, this system stores the history of transactions and backup data in blocks which is immutable.

IV. LITERATURE SURVEY

Firstly we understand the seven major prerequisites before blockchains were introduced into property based applications like land registry systems and they are identity solution, digitized records, multi-signature wallets, a private blockchain, accurate data, broad internet connectivity and training of professional community that interacts with registration of property. An agile framework for blockchain is adopted here by proposing levels of blockchain recording, smart workflow, blockchain registry and peer to peer transaction to avoid middleman and interoperability. Case studies like bitfury, comaway, consenSys have set proper examples of platforms for implementation of blockchain in property and registry [2]. Further, we come to realize that implementation of blockchain and thus modifying the traditional system makes the system easier and efficient and thus the process of digitization of land records using blockchain technology to overcome the drawbacks of existing land registration systems was introduced. The existing problems such as delayed ownership verification, slowdown of legitimate transactions and the worst-case scenario of frauds which may happen during purchase process. With an attempt to overcome these, according to case studies and research conducted in the cities of Honduras and Georgia, use of proof of existence, proof of audit and proof of process for establishing permanent timestamped digital records is introduced to avoid visual manual verification and thus the first step towards replacement of their existing land registration system with a transparent, faster, secure, convenient, efficient system was taken [3].

Further in depth description on blockchain technology and its applications with a motive to discuss its taxation, architecture and key characteristics is understood and simultaneously an emphasis is projected on learning different types of consensus algorithm that can be used and various challenges faced. The characteristics of blockchain include decentralisation, persistency, anonymity and auditability that help overcome the drawbacks of traditional system with a major focus on eliminating the necessity of a third party for validation of transactions. The architecture of this technology refers to forming a chain with blocks so as to adhere to the idea of immutability. Consensus model is to be employed in this process to determine which block is added to the chain along with consensus strategies like proof of work, proof of concept and so on and the way in which blocks are validated whereas taxonomy deals with questions like who can access the blockchain network and how the permissions are consigned. This technology's major applications are well

rooted in the field of finance and taxation, asset management whereas the challenges faced pertain to business domain and technology. Now the major focus is laid on correctness of knowledge stored and resolving which type of implementation - permissionless or permissioned can be used [1].

Next, Hyperledger Fabric blockchain technology is introduced. It lays down various features of a hyperledger fabric environment. This fabric provides a permissioned network that runs a blockchain among a group of known, identified participants and the way this helps overcome the drawbacks of permissionless networks is discussed elaborately. Fabric aims to be flexible, scalable and confidential and at an equivalent time its design is all about modularity and extensible general purpose permissioned blockchain. It supports standard programming languages that are executed consistently across many nodes, making Fabric a distributed OS for permissioned blockchains. The architecture with its various components just like the peers, organizations, endorsement policies, ordering services and other components are described intimately [4]. Alongside, the ecosystem that consists of the application layer, the smart contracts or the business logic, the consensus algorithm and the blockchain ledger, has also been discussed. Furthermore, reader's and researcher's insight to further explore possibilities of this technology to work in the domains of IoT security, healthcare, business and many others, such as, vehicle tracking - real estate - Banking is discussed while highlighting explains how blockchain adds value to a business and how there has been an investment growth with the use of this technology in the business world [5].

Blockchain is a mechanism to bring everyone to the highest degree of accountability. Many giant IT firms believe that a blockchain technological system can help businesses to increase the operational efficiency and speed up the process, reducing cost and time related to reconciliations and disputes, as well as possibly enable new business models by increasing revenues and savings. Blockchain has diverse applications and has the potential to be leveraged in different aspects of management and technology. The use of cryptocurrencies will help our life to be more comfortable by 24/7 services, secured, get rid of material oriented notes and coins, and directly and indirectly help to sustain financial ecosystems. Hence, there is a huge potential in the business of developing new cryptocurrencies coding, transactions, storages, exchange rates, standardization, and security mechanisms to adopt these disrupting financial technologies [13].

V. PROPOSED SYSTEM

In recent times, a lot of problems are faced by commercial real estate industries and land registration systems where even though the data is in digital form, they are stored on disparate systems and thereby lack transparency, trust and efficiency. The intention is to implement a small module of the land registration process with regards to the state of Maharashtra.

We propose a private and permissioned blockchain system that restricts the participants who can contribute to the consensus process, to overcome the obstacles faced earlier as mentioned. Our blockchain system makes use of Asymmetric cryptography for security of users and distributed consensus algorithms for ledger consistency. The main features of blockchain technology are decentralisation, persistence, anonymity and auditability and an amalgam of these results in reduced cost and improved efficiency, reliability [5].

In comparison to a centralized traditional system in which different observers may have different views of the system and the observers are compelled to trust the central authority for verification and authentication, blockchain allows anyone to verify the correctness of the state of the system. In this set up each of the state transition is confirmed by verifiers which can be restricted to a set of peers as well [5].

In our portal, we register land users by taking into account all their credentials and mandatory verified documents where the admin invokes the smart contracts "Put for Sale" and "Change of Ownership" for the purpose of selling and buying the land. Once all the necessary conditions are met then only the user is eligible to buy or sell the land. After the completion of the transactions one can view all the transaction history including all its previous owners, the date of purchases and summary of all land details. The lands are displayed area wise or land id wise as per the user's convenience. Thus our system works efficiently and caters to the need of a modified and decentralised land administration system.

A. Components of the System

The currently existing land registration system is proposed to be replaced by the blockchain technology of hyperledger fabric. Hyperledger Fabric is a modular and extensible open-source system for deploying and operating permissioned blockchains [8]. It is a business specific distributed ledger technology platform that contains the following elements as seen in figure 1 [12].

The components involve peers, certificate authorities(CA), chaincode, orderer, membership services(MSPs), channels and Hyperledger Fabric Client(HFC). There are 2 types of peers, the endorsing peers who can make changes and have the smart contract and the committer who commits all transactions that others are performing. CA verify and authorize each peer. This can be a pluggable entity. Smart Contract / Chaincode contains the business logic and it runs on the blockchain. Every node on the network executes it. This contains all the land registration related validations and changes in the assets. The Orderer orders the transaction in a correct order and writes a transaction on the ledger only when the majority of the peers order the transaction in that order. MSPs provide identities to users performing transactions. Channels are networks on which if peers are present, they can access the ledger using the chain code. SDK/HFC is used to communicate with the blockchain and perform transactions.

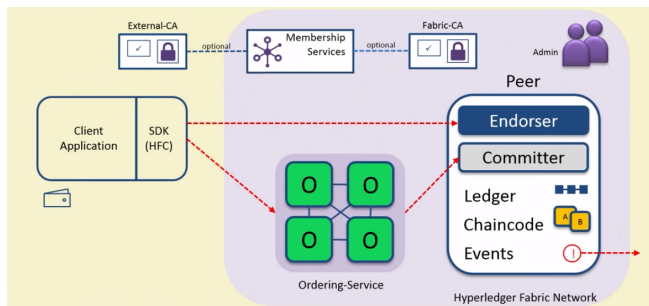


Fig. 1. Hyperledger Fabric Architecture

B. Functionality of the System

The transaction flow in a Hyperledger Fabric [9] [12] is as follows:

- 1) **Propose Transactions** : The Client Application proposes a transaction to multiple endorsing peers. The number of peers is determined by the endorsing policy. The client application needs to satisfy this Endorsement policy to communicate with enough peers to collect endorsements.
- 2) **Execute Proposed Transactions** : Each of the endorsers has to execute the transactions proposed. Each execution will capture read and write sets. Once captured these sets are collected for the transaction and each endorser will sign it.
- 3) **Proposal Response to Client** : Endorsers communicate back to validate the output with their signature. The client or SDK will now receive the read and write sets asynchronously.
- 4) **Ordering Transactions** : Once the client gets sufficient endorsements according to the endorsement policy, it will submit the transaction to the ordering service. Multiple client applications or users across the network simultaneously send their transactions to the ordering service. Ordering service determines how to order the transactions and also ensures that all peers on the network can see the same order.
- 5) **Deliver Transaction** : Ordering service delivers ordered sets of transactions(block) to all the peers in the network, it asks them to add this block to their blockchain.
- 6) **Validate Transaction** : All peers receive a block of transaction, but not all transactions in the block are valid because some of them do not get sufficient endorsements. When all peers on the network come across such invalid transactions, they reject or mask that transaction.
- 7) **Notify Transaction** : All peers, on a per peer basis, commit a set of valid transactions(block). This block is then added to the blockchain and each block emits events to notify that the block has been added. Events may be block events, transaction level events or smart contract events.

VI. METHODOLOGY

A. Approach

To overcome multiple problems discussed earlier, blockchain implemented by hyperledger fabric was proposed to replace the existing system. The hyperledger fabric is a blockchain platform that is an open source and business specific distributed ledger technology. The working has been divided into 2 modules where module 1 gives a detailed description about the working of the administrator with regards to registration and invoking the smart contracts where as module 2 gives a detailed brief of procedures related to change of ownership and completion of the purchase of land.

As the flowchart in Figure 2 suggests, using the hyperledger fabric platform one has to follow the following steps to register a land to their name. The platform is handled by an admin peer who acts as a super admin and manages all transactions and records.

- 1) **Register Users** : The admin adds users to the platform by filling in a form with their details that include their name, email, phone number, their unique identification (like aadhar and pan card) details, their occupation, their account balance, their electricity bill to verify the address entry and the criminal history details of the user(if any).

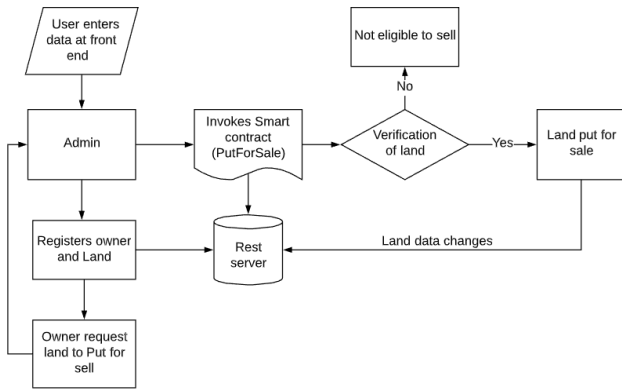


Fig. 2. Module 1: Register Users and Put Land for Sale

- 2) **Register Land** : The admin then adds the land asset record by filling a form that contains the land identity number, the location of the land, the type of land, the price of land in units, the size of the land in acres, the 7/12 contract details to verify the land, the corresponding contract number and finally the identity number of previous owner and the current owner of the land.
- 3) **Put a land for Sale** : When requested by the User (owner) to put his land for sale, the admin invokes the PutForSale transaction that in turn invoke the smart contract that contains the business logic for putting his land for sale. A land asset can only be put to sale if the following conditions are satisfied :
 - a) **Government Verification** : The land asset will be verified by the government if the price of the land is in the given lower and upper ranges of the acceptable price of the land as mentioned by the Maharashtra government. The values of the price range vary from time to time and city to city.
 - b) **Registrar Verification** : The land asset will be verified by the registrar and the sub registrar only if the registrar accepts the land documents and the seller's criminal record is also taken into account to verify the land.
 - c) **Collector Verification**: The land asset will be verified by the collector only in extreme cases when lands that are Forest, Government or Religious based, to avoid any discrepancies.
 - d) **Put the Land for Sale** : The land asset is put for sale only if all the verification is done.

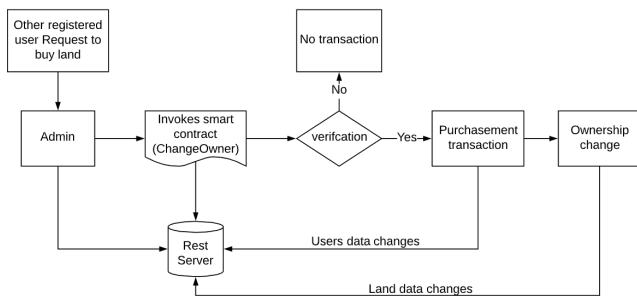


Fig. 3. Module 2: Change Owner of Land

- 4) **Change Owner of Land** : When a User (buyer) requests to buy a land asset, there needs to be a change of owner

of the land. Prior to this change, some conditions are to be cross checked. The buyer is not supposed to have any criminal record. The buyer should have an account balance that must be greater than the amount that the land registration is going to cost him. The land must have been put to sale by the seller. After these conditions are satisfied the following steps take place:

- a) **Changing Owner** : The current owner is assigned to the previous owner attribute, while the buyer is assigned to the new owner attribute of the land asset.
- b) **Money Transfer** : The seller gets the amount he quoted on the land into his account, while the buyer has to pay the quoted price along with some additional charges like the stamp duty and registration fee (to the registrar). The value of the fees vary from time to time and city to city.
- c) **Initializing state of land** : The land asset now belongs to the new owner. It is upto him to put the land for sale or not. So this attribute of the land is reset for the new seller until he decides to sell the land later.

B. Algorithm Implementation

Land registration needs special attention to all its constraints. If a seller wants to sell a piece of land to the buyer A at a certain price x while to the buyer B at price y. The buyer A should be unaware of the price quoted to buyer B and vice versa. In this way the seller can deal with his buyers in a more personalized manner. Such transactions are possible only when using a permissioned blockchain network. This would not only help in increasing confidentiality of data among multiple customers, but also maintain the privacy of the business between the buyer and the seller. Other participants involved in the business are also not aware of the internal details of the deal. They only focus on whether the transaction can be validated according to the constraints specified in the smart contract.

A hyperledger is thus used to recreate the land registration system as it is a permissioned blockchain platform that can be specialized for each business, in our case, the land registration system. It can be considered as a ledger, that contains all entries of the lands and users. This ledger is only changed when an application invokes a smart contract which is called a chaincode in hyperledger.

VII. ALGORITHM ANALYSIS

Blockchain technology has many approaches to a different problem statements. All these approaches have to be compared and based on the analysis the best approach for the current problem has to be selected. Some of the blockchain approaches include ethereum, cosmos, EOS and hyperledger.

These blockchain technologies were filtered out based on its usability for our application. Thus the shortlisted blockchain approaches were Ethereum and Hyperledger. These seemed to be more suitable for our use case. Based on the comparison chart above a deduction was made that Hyperledger was best suited to replace a Land Registration System. A detailed comparison between ethereum and hyperledger that helped choose the blockchain technology is given in table I

Ethereum	Hyperledger
Any node can be added to the peer to peer network. Nodes may not know each other.	Only nodes that belong to the business are allowed to enter the peer to peer network.
The blockchain network is permissionless so all nodes in the network can access the blockchain and execute transactions on it.	The blockchain network is permissioned so only nodes that are participants of the business can access the blockchain and execute transactions on it.
For a peer to execute a transaction the requirement is to have proper storage, processing power and computing speed to solve a complex.	For a peer to execute a transaction the requirement is to be a participant of the business.
It is based on the algorithm of consensus used, a node can access the information based on the computer's capability.	It is based on the algorithm of consensus plugged, the nodes can access the information based on the order of transactions submitted.
Privacy and confidentiality of the business deal are compromised	Privacy and confidentiality of the business deal are maintained.
Ethereum is a generalized and standard method that is applied the same for all the businesses.	Hyperledger is a more specific and business oriented that applies different logic to different businesses.

TABLE I
COMPARISON BETWEEN ETHEREUM AND HYPERLEDGER

VIII. RESULTS AND TESTING

A. Methodology

The basic implementation of a hyperledger fabric [10] takes place as shown in the Fig 4. The elaborate step wise working is explained below.

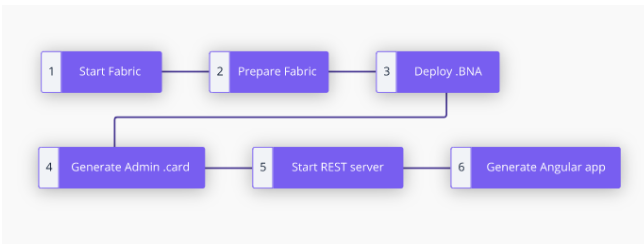


Fig. 4. Basic Implementation

A network is created and all the required entities like the certificate authority the orderer, the database (couchdb) and the peer of the organization are created that are required initially to set up the hyperledger environment. Then the first network admin card called the PeerAdmin card is generated. A peer admin business network card must be created in order to deploy a Hyperledger Composer business network to a Hyperledger Fabric instance.

The yeoman generator is used to create a skeleton of a business network structure. The main feature of a hyperledger composer is to have a business network definition(BND) that defines the data model, the transaction logic(chaincode) and the access control rules that manages the business altogether. This will create a directory containing all of the components of a business network. The .bna file is an archive of the above 3 files created by the yeoman generator. The business is now in a deployable state on the hyperledger fabric by installing the business network onto the peers.

The network is deployed and started where the specifications like network name, version, admin and the network card on which the admin is deployed is specified. Then the network administrator identity as a usable business network card has to be imported. Checking of the business network

card created above is done by pingging it. It returns the participant and gives it a system identity. The hyperledger composer rest server is started using the network card to give it a test interface. Using this Rest Server contains all the elements of our business network and the hyperledger fabric contacts the angular front end using this interface

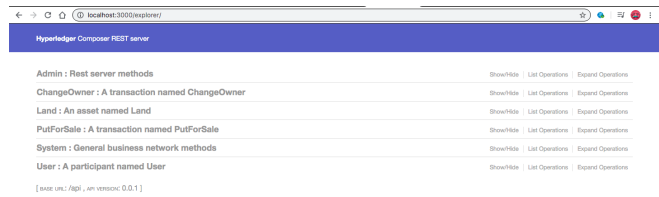


Fig. 5. Hyperledger Fabric Composer Rest Server

The yeoman generator is used again for the purpose of building the front-end for the existing business network using Angular. This will create a basic angular interface that is ready to communicate with the rest server.

IX. TESTING

When a transaction is invoked for selling the land the PutForSale attribute of that land becomes true, as seen in figure 6, because all the three prerequisite conditions are met.

Land												Create Asset
landId	price	address	size	description	contractNo	govVeri	regVeri	coVeri	forSale	prevOwner	owner	Actions
34526	5000	satara	5	Government	526	false	false	false	false	12345	23456	✎ 🗑
40022	5000	mulund	50	Forest	022	false	false	false	false	56789	23456	✎ 🗑
56789	7000	palghar	12	Agricultural	789	false	false	false	false	45678	56789	✎ 🗑
68456	6756	mulund	4	Residential	456	true	true	true	true	53456	12345	✎ 🗑

Fig. 6. Change in Land Record after invoking PutForSale Transaction

When a transaction is invoked for buying the land, the owner of the land changes. Even the account balance of the users involved changes. User1 sold the land to user2 and the amount is credited and debited from their accounts respectively where stamp duty, taxes and registration fees are considered according to the figure 7

User										Create Participant
userId	email	name	phone	address	work	accountBalance	bankName	hasCriminalRecord	isVerified	Actions
12345	user1@gmail.com	user1	836938351	thane	Engineer	56756	icici	false	false	✎ 🗑
19237	user9@gmail.com	user5	9495708095	powai	Lawyer	100	sbi	false	false	✎ 🗑
23456	user2@gmail.com	user2	982389536	pune	Doctor	32970.76	axi	false	true	✎ 🗑
45678	user3@gmail.com	user3	8168279153	parvat	GovernmentJob	35000	indian	true	false	✎ 🗑
53436	user6@gmail.com	user6	836938352	thane	Farmer	10000	punjab national	false	false	✎ 🗑
56789	user4@gmail.com	user4	836938353	nerul	Doctor	2000	icici	false	false	✎ 🗑

Fig. 7. Change in User Records after invoking ChangeOwner Transaction

Verification is done on 3 levels as mentioned in the methodology. For this lands need to be verified by government authorities, registrars and collectors. Only then can the land be put to sale. Under this verification certain lands which cannot be sold are correctly falsified to prevent sale of fraudulent lands or involvement of fraudulent users.

All the system as well as performed transactions can be viewed under the all transactions tab to get to know the last transactions that took place.

