Decentralized Land Title/Transactions Registry

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Abstract

While the Web2 was a frontend revolution, the Web3 is a backend revolution. It is a set of protocols led by blockchain, that intends to reinvent how the Internet is wired in the backend where Blockchain acts as a transparent, immutable and decentralized/distributed world computer. Moving towards Web3.0, using blockchain a transparent, decentralized and immutable public ledger could be the best solution to the current issues faced with the land registry. A secure property registry built on the Blockchain can secure billions of dollars in assets and make a significant social and economic impact globally by addressing the rapidly growing demand for transparency and accountability. A Blockchain-based registry also allows the government and individuals the ability to audit quickly. It also allows for substantial reductions in the cost and time required to register and transfer property.

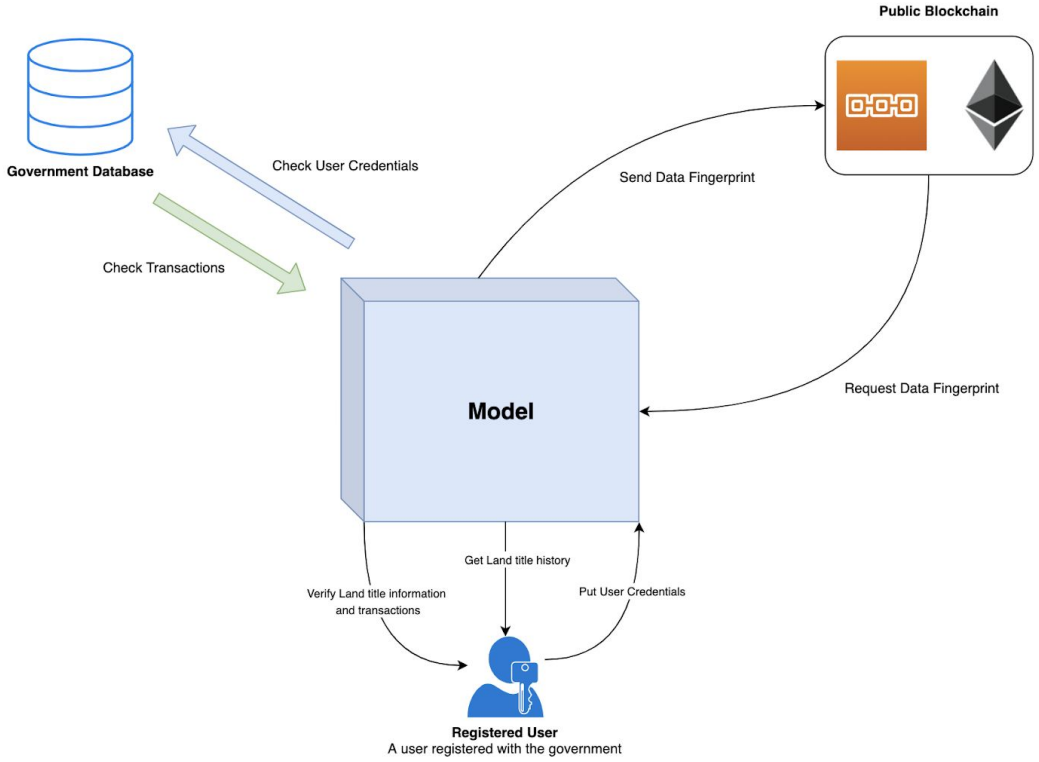
Introduction

Blockchain is an electronic ledger of digital records, events, or transactions that are hashed cryptographically, authenticated, and controlled through a distributed or shared network of participants using a group consensus protocol. The blockchain is distributed among millions of computers with mechanisms for validating transactions that utilize a group consensus protocol. Blockchain technology is the way of looking differently, the inner functions of the normal database which gives the power to a single authority like administrators who have the ability to change the information in the database if they want to. This power can be abused by unfaithful administrators. Normal database suffers the problem of a single point of failure and makes them depend much on backups in case of failure and when both running database and backups are harmed can bring very serious problem.

This research aims at proposing a model for secure and robust land administration and title registration systems based on blockchain technology, which will help in eradicating the weaknesses shown in the current land registration and administration process. Land administration and registration systems with blockchain technology are implemented in Ghana, Estonia, Georgia, and Honduras. Although they are still in their initial stages, there are challenges and strengths which have already been experienced. The challenges in all countries are the lack of awareness of blockchain technology to the society and difficulties in the registration of titles that are still in conflict. The strength of the systems is the ability to time-stamping transactions analogous to virtual notarization, disaster recovery as the system does not rely on a single data center and recording of details in a tamper-proof and immutable. In India, Blockchain technology is in its nascent stage and its disruptive applications in many areas have either not been discovered yet or not applied in scale. There are many problems with the current land registration problems in India as well - Long and expensive process to get the land title and transactions verified, no ultimate source of truth, mutable data in central databases, etc. Blockchain can act as a disruptive force to tackle the problem with the land registry at scale.

Model, Requirements and Use Cases

Basic Design Architecture and Relationship Map:



Basic Design Architecture of the proposed model for Land title registration and validation

Model

The proposed model has the following features:

A web-based interface:

The web interface provides usability features like login and the ability to verify/validate the land titles and transactions. Once a user has been authorized, the user can enter the required IDs and details for the land titles and transactions which can then be fetched from the blockchain and verified.

Encrypt/Decrypt engine

The Encrypt/Decrypt engine is used to encrypt the latest data from a government database and send it to a public blockchain where it is embedded. It also retrieves and decrypts the embedded data in the blockchain so that it can be verified. Using a secure key, the information can be encrypted in a way that only the users having access are able to decrypt the information. Due to these reasons, the encrypted data can act as a fingerprint of the highly sensitive land title and land transaction data.

A web3 component which communicates with the public blockchain

In the proposed model, the web3 component is used. It is used by the Encrypt/Decrypt engine to interact with the public blockchain. It is also used by the web-based interface to fetch and verify the blockchain data.

Actors

- **Government Database (GovDB)**

  The Government Database is a centralized Government Database that would have all the data related to a nation's registered user base. The model would also refer to this centralized database to allow access to registered individuals.
- **Registered user**

  This includes any users who are registered to view the data and land title history and authorized to validate the land titles (Ex: Land buyers, sellers, registered government officials, bank officials etc.). More details in the target users section.
- **Web interface**

  This the interface wrapping the model which would be used by the users to login and view the land title and transaction data and the land title history.
- **Web3 component**

  This component will act as a bridge between the frontend components, the microservices and the blockchain backend (Ex: Web3.js).

- **Distributed Public Blockchain**

  This would be the public blockchain where the fingerprint of the sensitive land title and transaction data would be stored. Ethereum is one of the best options as we can have programmable logic in the form of smart contracts for Ethereum, but public blockchain like Bitcoin can also be used for storing only the fingerprint data as it is the most trusted data proof store available.

Functional Requirements:

The proposed model should:

- Send encrypted fingerprint of information present in a government-regulated DB to a decentralized blockchain
- Validate land title information
- Validate land title transaction
- Get land title history.

Non-Functional Requirements

Security:

The proposed model would handle very sensitive data, so security is very important. Only users registered in the Government's database would be allowed to access this data. The information sent to a public blockchain would just be the fingerprint of the information stored in the Government's database, so it cannot be harmful even if it falls in the wrong hands.

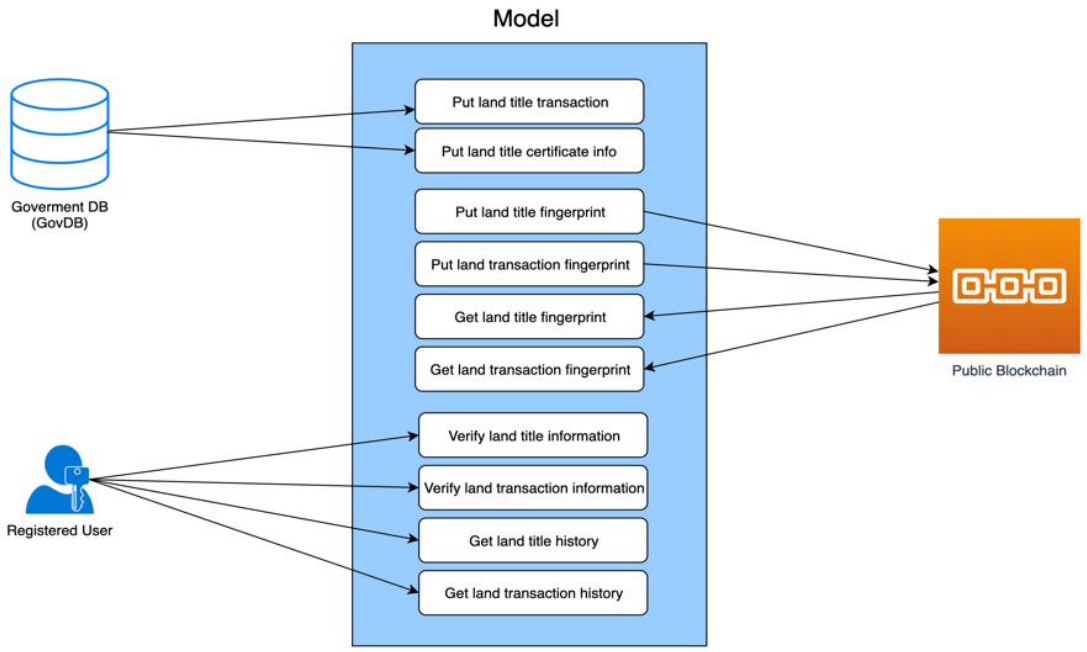
User Interface and Environment:

The model's user interface would be in a web-based format that could run on any environment which supports a web browser. Iteratively, it can also be extended to a multi-platform app that can be used by all stakeholders.

Availability:

The model will get all of its data from the Government Database, and the public blockchain. The information from blockchain guarantees the availability of 99.9%. This is because the same copy of the information is stored in thousands of nodes/computers. The information from the Government database would have its standalone availability.

Use Cases:



Use Case Diagram

The proposed model should have the following use cases:

Encryption and entry of Land titles and transactions and embedding the fingerprint in public blockchain.

The moment a particular piece of land gets a new title, or a land transaction takes place and the required government notarization has been done, it is entered in the government

database (GovDB). From there it is pulled by our model and encrypted. The hash (fingerprint) of this data is then sent to a blockchain.

Journey Flow:

1. A new land transaction is completed, or land gets transferred to a new owner.
2. The transaction is assessed by a government-regulated body.
3. Once the transaction has been verified and notarized by the government, it is then
4. entered into the Government database (GovDB) and marked as notarized.
5. The notarized data is then pulled from the GovDB and encrypted.
6. Web3 component is invoked and the encrypted data is sent to the blockchain.
7. The GovDB is updated again by the model and marked that the fingerprint of this data has been embedded in the blockchain.

Verification of land title information/transaction:

Any land title or transaction data stored on a blockchain can be verified by a user registered with the government. One a registered user logs in, the verification status can be displayed on the user interface marking whether the entered land title or transaction info entered is valid or not.

Journey Flow:

1. A user goes to the URL which points to our model.
2. The login screen is displayed to the user and the user is prompted to login or register.
3. If the user is not registered, they're prompted for registration.
4. If a registered user wants to login, the credentials are entered in the UI.
5. The model check if the user is registered by checking the credentials against the GovDB where all registered users are stored.
6. On positive response, the user is given a web-based form to enter the land title and transaction details which the user intends to verify.
7. The model takes the fingerprint of the IDs and the data entered for it to be matched against the blockchain data.

8. The model invokes the web3 component and retrieves the data from the blockchain for the entered details.
9. If there was a match on the blockchain, the data is retrieved and decrypted.
10. Then the data is matched and compared if the transaction or title is valid.
11. The result is then displayed back to the user in the UI

Get a history of land titles or transactions:

For a given land, the history of transactions and the transfer of titles can be retrieved from the blockchain. This holds for only those transactions and titles which have been entered in the blockchain. A registered user, after logging in can enter the details of the land title or the registration and our model can fetch and display the history to the user based on both the transaction and the title level.

Journey Flow:

1. A user goes to the URL which points to our model.
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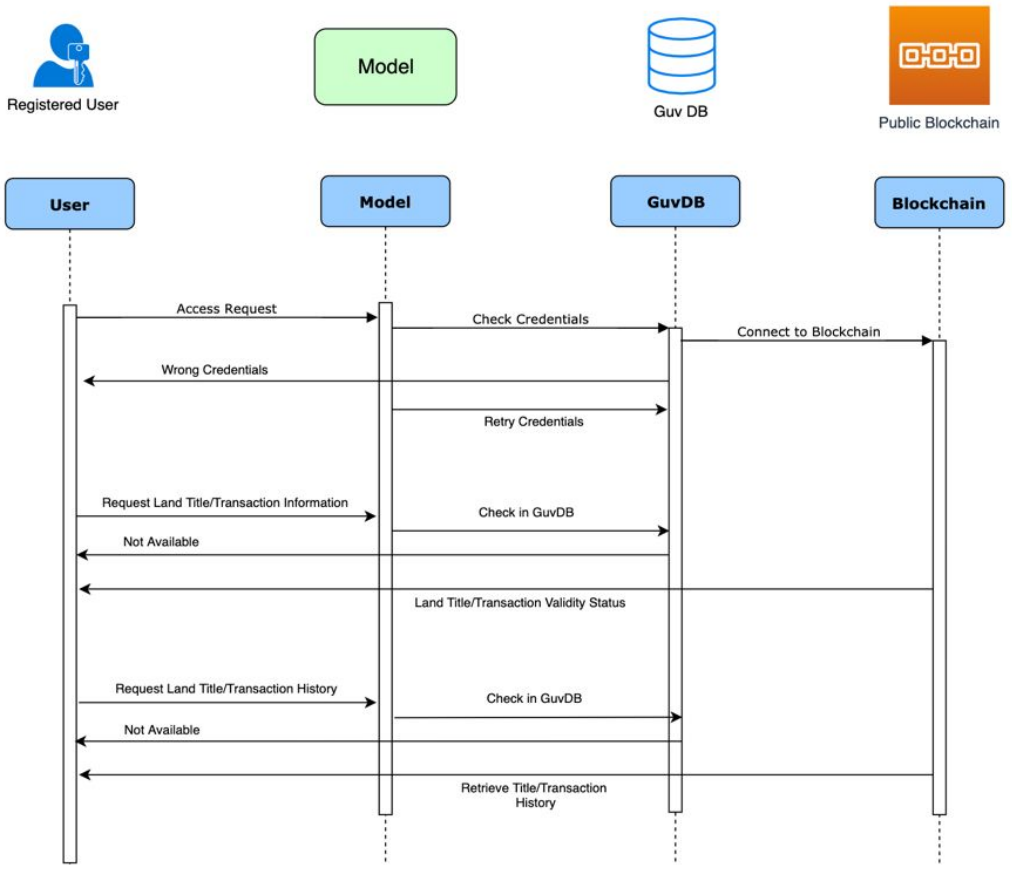
3. If the user is not registered, they're prompted for registration.
4. If a registered user wants to login, the credentials are entered in the UI.
5. The model check if the user is registered by checking the credentials against the GovDB where all registered users are stored.
6. On positive response, the user is given a web-based form to enter the land title and transaction details which the user intends to verify.
7. The model takes the fingerprint of the IDs and the data entered for it to be matched against the blockchain data.
8. The model invokes the web3 component and retrieves the data from the blockchain for the entered details.
9. If there was a match on the blockchain for the ID provided, the data is retrieved and decrypted.
10. A paginated list of the history of the requested land title or land registration is then presented back to the user in the UI.

Sequence Diagram:



Sequence Diagram

Target Users:

This model can be used by any user registered with the Government and having the prerequisite access. It would include.

- Registered buyers.

Buyers who are interested to buy a piece of land and want to know the current owner of that land can get accurate info. They can also get the transaction history before they make the decision to purchase that land.

- Registered Sellers.

  Sellers who are interested to sell a piece of land can get their land registered so that other buyers can check the current owner of their land.

- Registered Government officials.

  Registered Government officials and officials from the Land regulatory department can login

- Registered Bank Officials: Before providing a loan for land purchase, banks can do accurate verification of the true owner of the land and also on land transaction history to accurately detect fraudulent transaction.
- Registered public authorized to check the validity and history of land titles and transactions.

Extended Use Cases:

- This model can be extended to serve the data on an international level as well thus helping in reducing international land conflicts.
- This model can help in quick disaster recovery and aid both nationally and internationally. With this model, it would be much faster and accurate to verify the land owners of the land affected during floods, earthquakes etc.
- This model can also be populated with historical data once they have been thoroughly verified be government officials. This would help in having an immutable source of truth for historical land titles and transaction history even before the time the model was developed. This would increase the time based scope of the benefits of using blockchain as a disruptive solution for an immutable ledger.
- As the data fingerprint stored on the blockchain would be the ultimate source of truth, registered third party services having the authority to decrypt the sensitive land based data can also data science and machine learning techniques to get a great

overview and visualization of the current validated land titles and transactions and its history. If leveraged by a government body, this could provide extremely accurate insights to the current state of land registry.

Research

I've done extensive observational research by exploring a lot of case studies, articles, data points and research papers present on the internet. This observational research helped in a better understanding of the challenges faced by the current land registry use cases and flows and also some of the solutions which have been designed using blockchain technology to tackle the problems which persist with the land registry. I have also conducted an interview with a colleague who recently faced stressful problems due to the unavailability of a single source of truth for validating land titles and transactions. The interview notes have also been added in the required format.

Interview:

Interview Date - 2 Oct 2019
Interviewer - Shantanu Singh
Interviewee – Vishwanath K
Relationship with the interviewee - Office colleague

Shantanu: Hi Vishwa
Vishwa: Hello Shantanu
Shantanu: Thanks for agreeing to take this interview. This interview is mainly to discuss the problems faced with the Land registration process in India and how one can tackle it in an efficient way. Recently you had mentioned in one of our conversations that you faced a problem relating to a piece of land you bought many years ago.
Vishwa: Yes
Shantanu: Can you explain in brief what you encountered?

Vishwa: Sure, I bought a plot of land around 11 years back in northwest Bangalore. As with other of my land purchases, I diligently followed all due processes, got the land registered in my name, notarized and finally after all processes were completed, I was able to get possession of the land. I took a loan to purchase it and the bank officials also checked if everything is properly registered and notarized so that the band loan can be provided. I then also got one small house built there and got an electric connection there both of which also required a proper assessment of the land and the notarization by the government officials. All was fine for 10 - 11 years when a few years back I got a call from a person enquiring about that same piece of land. He mentioned that he had purchased this land many years ago and asked me to deconstruct the house which I've built there so that he can build his house there. At first, when I heard this, I was taken aback and was quite surprised as I was thinking that if he owned this piece of the land why did he approach me only after 10 - 11 years and he never came for inspection before that. I then asked him in another call, to present all the documents to prove that he owns that land. He forwarded, all the documents and notarizations and to my shock, all of the documents seemed correct and properly notarized. I thought to myself that this could be a case of the same piece of land fraudulently being sold to two people at the same time. Then I also received a notice from this person stating that this piece of land is owned by him and that I should be vacating this land. I had also noticed that in his documents he didn't have a bank loan or any electricity connection for this land which further strengthens a person's claim on this land as in that case, the land also gets certified and assessed by the bank as well as the government officials. That is when I thought that I should take this guy to the court as I had more solid proof and data points with me than he had. Just before approaching the court, in one of my discussions with my Lawyer, we carefully analyzed the papers he had forwarded to me stating that he's the owner of the land and that's when we found that in multiple papers, someone had skilfully photoshopped some registration numbers. In a nutshell, all the papers he had forwarded to me were fake and manipulated. When we went to the registrar's office, they also confirmed that the notarization is authentic, but the registration number has been changed and is incorrect. That is when we called the fraudster and confronted him about his faked documents after which he abruptly cut the call. We tried reaching him again but he kept his phone switched off. No further notices were also sent to

my house regarding that land after that as well. We went and complained about this to the police as well and they registered the complaint and are on the lookout for that person.

Shantanu: That must have been a stressful experience for you during that period.

Vishwa: Yes, it was quite stressful, a bit expensive as well. And this has happened to a few of my friends and family many years ago as well.

Shantanu: Interesting. So as this problem is a serious and persistent one, there could be a possible solution to this problem using blockchain and using it's transparent, immutability and decentralized power.

Vishwa: Interesting.

Shantanu: Yes, a problem like this which you or many others face is mainly due to the fact that the land title registration stored in the central database is not the final source of truth on land ownership. These documents are also prone and susceptible to forgery and manipulation, which could ultimately act as a fake source of truth and due to lack of any other means to verify this source of truth, it can be misused for fraudulent transactions. If we store a fingerprint of the certified and notarized land registrations after they're properly certified by a government body, then that fingerprint stored on a public blockchain would be embedded in time and is tamperproof. This is because that information, when entered in a public blockchain, would then automatically be stored to hundreds of thousands of computers as soon as that transaction is processed and it is nearly impossible to change that data. This could help to validate any Land title or transaction is much lesser time and the data stored on the blockchain could serve as an ultimate source of truth for this data.

Vishwa: That would be great. I think that would work really well and could solve a lot of problems. Is it very complex to implement?

Shantanu: It is not complex or expensive either.

Vishwa: That is great. I think this solution should be implemented in scale as it has good potential to disrupt this space and the problems attach to the land registry.

Shantanu: Yes, definitely! Thanks, Vishwa, I'd like to conclude this interview. Thanks for sharing your experience and insights.

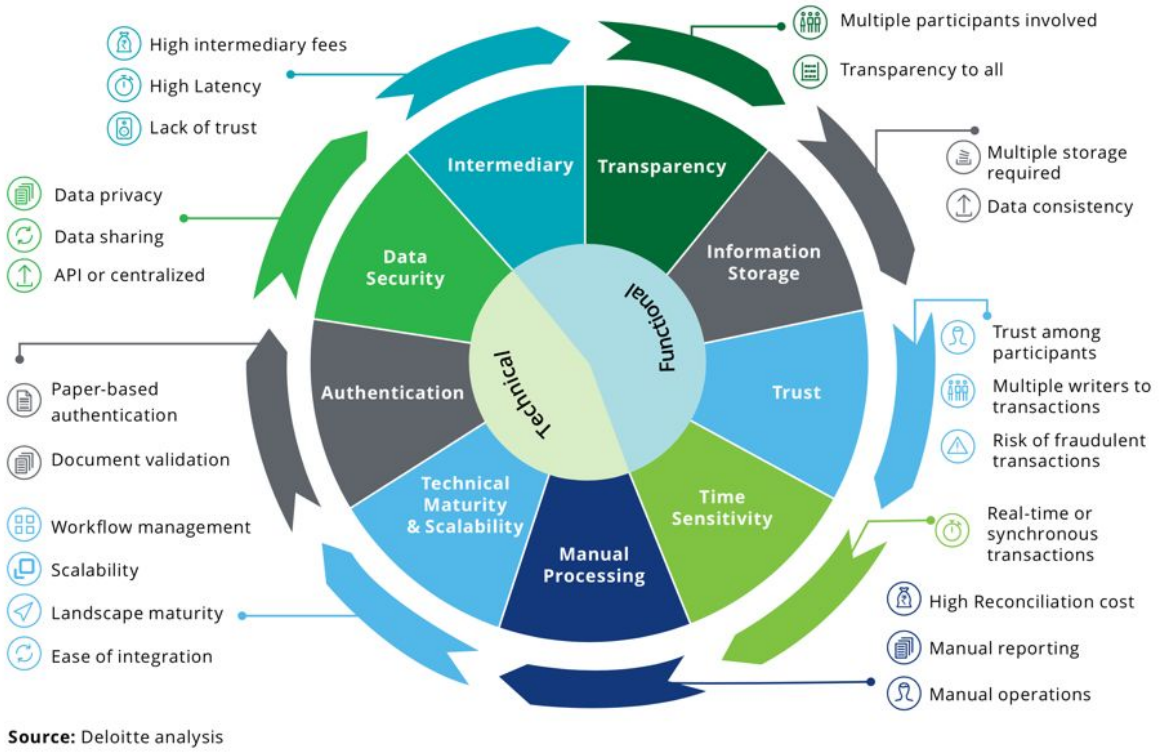
Vishwa: No problem at all.

Interview Notes:

From this interview, I derived that one of the main pain points of the current land registry in India is not having an ultimate source of truth which can be used to verify a land title.

Blockchain Fit Assessment

Experimentation is necessary for a solution to emerge, it is important to select the right use cases for a better probability of a viable business case when the solution is scaled to production. A blockchain-based solution will be a good fit for use cases where multiple parties are having low levels of trust and transparency with each other. The technology will be applicable in areas where the same transaction information is getting stored across disparate systems or databases. Blockchain fit assessment is also dependent on the time-sensitivity of data, cost of reconciliation, need for data security, and the requirement for authentication. However, if only one party exists, a blockchain does not provide additional guarantees vis-à-vis the traditional applications using a database. Using the **Blockchain Fit Assessment model** (see Figure below) analyzed by Deloitte, we will observe in the following case studies, how a blockchain is a right fit for having a decentralized, transparent and immutable ledger for land titles and transactions.



Blockchain Fit Assessment Model

Case Studies

Case Study: Land registry in India

There is a growing need for large scale adoption of exponential technologies in India. While it may seem challenging at first, it is possible as evidenced by the pace of technology adoption in the country: India's telecom subscriber base crossed the 1.2 billion mark in May 2017, of which 1,180 million were wireless subscribers. India will account for 27% of new mobile subscribers globally by 2020, while China will account for 21%. With experiments for integrating blockchain and Internet of Things (IoT) gaining momentum across the globe, India is rapidly moving towards the next wave of the web — the Internet of Everything (IoE), the intelligent connection of people, processes, data, and things secured through cryptographic protocols and distributed consensus mechanism. The Digital India campaign launched by the Government of India in 2015 is also focused on digital empowerment of citizens through a combination of building digital infrastructure, providing digital services

and implementing e-governance in an accessible manner and using technology as a driver of change.

In India, blockchain saw early adoption in 2016 primarily among the players in the Banking and Financial Services industry. But with the beginning of 2017, India has seen blockchain adoption increasing amongst government bodies, Fast Moving Consumer Goods and Pharmaceutical industry. The NITI Aayog is working on building the country's largest blockchain network — IndiaChain, in a bid to reduce frauds, speed up enforcement of contracts, and increase the transparency of transactions. Securities and Exchange Board of India (SEBI) has established an advisory committee for conducting research on the blockchain platform and other emerging technologies. The committee comprises of eminent industry experts in the areas of education services, digital payments, process reengineering, data analytics, e-commerce, etc. The Reserve Bank of India, through its research arm Institute for Development and Research in Banking Technology (IDRBT), is also exploring the applicability of blockchain in the Indian Banking and Financial Services industry. Many Indian state governments and central government have demonstrated an interest in using blockchain across multiple use cases like asset registry, customs duty payments, and property transfer, to prevent tampering of data, remove duplicates and reduce counterfeits.

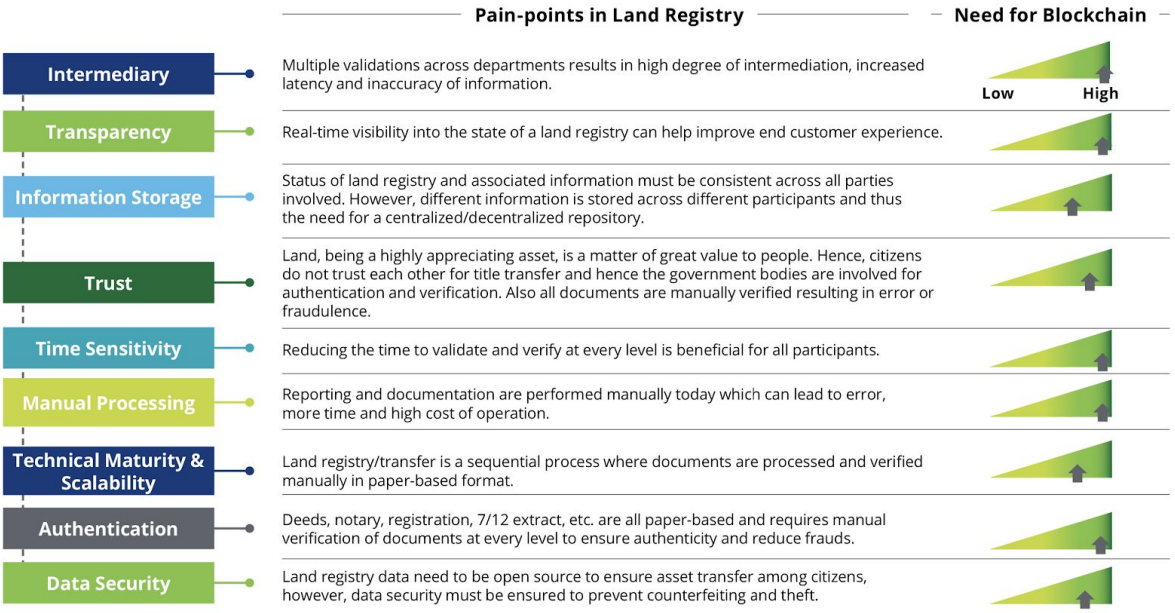
For instance, the Andhra Pradesh government is piloting blockchain in two departments – land registry and transport. The land registry pilot will track land ownership, while it will be used to streamline the titles of vehicles in the transport department. The state has also set up a repository of use cases for global start-ups to test their solutions. Through this initiative, the state wants to prevent tampering of land records, which have been digitized and placed online. Following suit, Telangana has begun a pilot program in parts of Hyderabad to use blockchain technology for land registration, while Maharashtra and Gujarat are also holding discussions with start-ups in the blockchain space and setting up a Fintech Hub to promote blockchain-based start-ups.

Land being the costliest asset in real estate has often been at the epicenter of land fights, crimes, and frauds. Deeds and titling not only provide critical protection for buyers in developed nations but also serve as a basis for investment and economic growth across many developing nations. By securing a unique and non-corruptible record on a blockchain

and validating changes to the status of that record across owners, a reliable land record can be created. Many countries are experimenting with blockchain to digitize their land records.

In the absence of any effective land records maintenance system, one of the biggest challenges that gripped India was about land ownership issues. Over the years, the Government of India has made multiple attempts at digitizing and making land records more secure and accessible. Of late, blockchain is attracting the attention of many state governments for recording land titles since it can provide a platform to record mutations, digitization of maps and integration of textual and spatial data, and survey and update of all survey and settlement records in a secure, immutable and tamper-proof manner. The **blockchain fit assessment** (Figure below) shows why the land registry use case is a good fitment for exploring the use of blockchain. One can observe that it fits well with the **Blockchain Fit Assessment Model** discussed earlier.

Blockchain Fit Assessment: Land Registry



Source: Deloitte analysis

The land registration process is highly manual and paper-intensive and involves multiple government bodies for verification and authentication. Land title transfer, on the other hand, involves repetition and duplication of processes, thus resulting in high processing time and cost. Maharashtra has already taken some strides in digitizing some of the processes involved in the land registration process. For example, an online facility is provided for

registering a lease and license agreement instead of the physical registration in the office of the Sub- Registrar. The Revenue Department of Maharashtra has also initiated a program for online Mutation in 73 talukas of 5 districts to ease the process of Mutation and reduce the need for physical documentation. However, many persistent issues remain. A blockchain-based solution could be a good fit to bring robustness and digitization to the entire process, bringing all stakeholders on a single platform as depicted in the process below.

In a blockchain-based land registration and title transfer process, all the players are on a single platform with distributed ownership rights. This provides transparency, automated verification and an irreversible trail of title transfer; thus blockchain enables a faster, secure and cheaper mode of asset registry maintenance.

Case Study: Land Registry in Honduras

Honduras is a Central American country with a total population of approximately 8.8 million. From an economic perspective, the country is characterized by an unequal distribution of income and high underemployment. Land ownership is unequally distributed and primarily concentrated in private hands, in large estates or smaller lots. A large proportion of minifundios lack title to their land. According to USAID (2018 estimates, the majority of the land privately owned is either untitled or improperly titled. Only 14% of Hondurans legally occupy properties. Lack of clear ownership titles has led to land disputes, conflicts, and displacement of indigenous groups. The invasion of private and communal land has become quite common.

Honduras reasoned that legal land titles issued by the central government through a land registration system would provide security that informal documents (e.g., oral agreements, quasi-legal documents) could not. Properly registered land claims would give the ability to landholders to defend those claims. In Honduras, each of the 18 Departments in the nation has at least one office where property registry information is recorded. Despite these efforts, the problem with today's Honduran land market is its inefficiency in terms of cadastral deficiencies, incomplete land information, the validity of land titles, and a lack of a

comprehensive land registry. Previous attempts to improve the manual land registry (by digitizing records into a centralized database) were plagued with problems ranging from duplicate titles to unauthorized changes due to carelessness or corruption. Against this backdrop, the idea to modernize the country's land registry with a distributed tamper-proof blockchain database was born. Honduras was one of the first countries to consider such innovation, and the publicity associated with this initiative improved the country's image worldwide.

In January of 2015, representatives from Factom, a technology company based in Austin Texas, and Epigraph, a software title company also based in Texas met with representatives of the Honduran government to discuss the possibility of developing a new system for land registry. The most pressing issue was the lack of backup for the physical land title records. "Land registry books dated into the 1880s, making all of the land wealth stored in those books vulnerable to arson, theft, or misuse". In March of 2015, the Committee for the Adoption of Best Practices (CAMP), met to approve the norms for the new Zones for Employment and Economic Development (ZEDEs). These are new economic zones with flexible and autonomous administration to promote growth and economic development. Factom was involved in several technology initiatives related to ZEDEs' land registry and company creation. The main appeal of the land registry at the ZEDE project was that blockchain could be used from the beginning to create new records since their inception. In contrast, the digitization of land registration records for the rest of the country would require the conversion of existing land titles. This is challenging since it requires additional steps, including the initial allocation of land rights by verifying the authenticity of existing titles (a resource-intensive task unrelated to the technology implementation).

Factom proposed a blockchain-based solution layer to maintain a permanent, timestamped record on top of the Bitcoin Blockchain. This is intended to establish a record's – e.g. a record of a land transfer – proof of existence, proof of process and proof of audit. Factom's data structures consist of: Directory blocks, Entry blocks, and Entries and a process that involves four main steps: 1. Application owner purchases entry credits with Factoid (Factom's token value); 2. The application records an entry—entries in a specific Chain can ignore entries in other chains, limiting the search space while keeping the event history. 3.

Factom server creates an entry block and directory block, and 4. Factom creates a directory block into the blockchain. The servers collect Merkle roots of entry blocks and package them into a directory block. If an application only has the Directory Blocks, it can find entry blocks without downloading every entry block. Entries are validated client-side by users and applications, which reject and keep records of entries that do not follow the rules. The validation process works as a random entry of instrument data to reduce vulnerability in the weakest link. Factom records the process but does not verify the validity of a transfer of ownership (e.g., who the owner is, the size of the parcel). This validation is done at the client-side. This is a critical component in the case of Honduras since verifying authenticity is a process that goes beyond implementing a technology. One of the weak points in a centralized system is data entry. To overcome this limitation, a Notary-Registry-Email verification with metadata for a visual verification check was necessary. Once transactions are validated they are stored in the blockchain, else the process starts again. First, the title is scanned and the metadata extracted from it. Three independent individuals verify the information and if all three agree, the instrument passes revision and leaves the system (to join the blockchain). Otherwise, it returns to the registration phase. At the ZEDEs meeting, Factom officials presented the blockchain solution described above. This method could have prevented corruption use-cases that had recently been discovered in the Property Registry.

From our interviews, we learned that negotiations to implement the Honduran blockchain land registry and the pilot program began shortly after the ZEDE Meeting. The two parties signed a Memorandum of Understanding (MoU) in mid-2015, followed by a non-binding letter of intent for a joint venture between the two sides from the Honduras government. The pilot project (proof-of-concept) would start in the La Ceiba's registry, the fourth largest city. Despite countless press reports about this initiative, the Honduran Government never made any public comments about it—only Factom officials gave updates. They explained the silence of government by arguing that the letter of intent included information that should not be disclosed to the public. At the same time, they admitted the difficulties of working with governments to update land registration systems. The CEO of Factom wrote in a blog post, "The project is political in nature, and government systems move slower than we would all like". Since this project happened near an election cycle, government officials were reluctant to introduce any major changes that could be used as a threat to the sitting

government. Had this project progressed, Honduras would have been among the first countries in the world to implement a blockchain-based land registry. The project was halted in mid-2017 due to the impending Presidential elections and has not been reactivated since then.

(Source - Castellanos, Arturo & Benbunan-Fich, Raquel. (2018). Digitization of Land Records: From Paper to Blockchain.)

Case Study: Land Registry in Georgia

Georgia is located between Turkey and Russia, bordering the Black Sea, in southwestern Asia. Although only a small portion of land north of the Caucasus extends into Europe, Georgia views itself as part of Europe. Its population is estimated to be almost 5 million—largely concentrated in the central valley and mostly around its capital city Tbilisi on the east. The country was part of the Soviet Union, with a small period of independence following the Russian Revolution. It was forced back into the USSR in 1921 but regained its independence when the Soviet Union dissolved in 1991.

In Georgia, buying or selling land was a long process. To notarize the transaction, buyers or sellers had to go to a public registry and pay a flat or expedited fee to notarize the transaction. The process was slow and prone to bribery. In the last few years, Georgia has taken steps to root out corruption and modernize their systems. In 2003, it ranked at the bottom of the Transparency International's Corruption Perception, but it is now in the top 50 (ranking 48th) in this index. The government of Georgia updated the public registry in 2013, and as a result, Georgia ranks third in the world for ease of registering a property according to The World Bank Doing Business report.

In 2014, BitFury - a San Francisco-based provider of Bitcoin blockchain infrastructure, installed a data center for mining Bitcoin in the city of Gori, with the support of the Georgian Investment Fund. The low cost of electricity, preferential taxes (free industrial zone), and the sustainable business and investment environment made Georgia an attractive country for BitFury’s foothold. In late 2015, BitFury announced its decision to invest $100 million to

build a data center in Georgia's capital, Tbilisi. A few months later, in April of 2016, BitFury announced a partnership with the government of Georgia to design and pilot a private permissioned blockchain operated by the National Agency of Public Registry (NAPR) and anchored to the Bitcoin Blockchain through a distributed digital time-stamping service. At the signing ceremony, government officials indicated that this project would cement their efforts to increase transparency and show that they can lead to changing the way land titling is done.

These investments and relationship building interactions certainly helped foster a collaborative environment prone to succeed, as stated by the chairman of the Georgian NAPR Papuna Ugrekhelidze, who indicated that he was "very pleased with the technical progress and looks forward to continuing [their] fruitful collaboration". BitFury's executive vice chairman George Kikvadze said the choice of partner enabled the pilot projects to move forward more quickly and efficiently: "we found the right partner in the Georgian government". After a successful pilot project, in February of 2017, Bitfury and the Georgian NAPR signed a new MoU (memorandum of understanding) to expand the system. BitFury representatives indicated that the software would be fully operational later that year. This project shows Georgia's commitment to increase transparency and rebuild trust in the land registry process. Georgia's property registration systems were ranked third according to the World Bank worldwide ranking, which gives additional assurances that the information entered into the blockchain-based system is valid and accurate. Distributed digital time stamping allows NAPR to verify and sign a document containing a proof of ownership of property. According to Georgia's NAPR, since the land-registry project was implemented in 2016, nearly 1.3 million documents have been uploaded.

(Source - Castellanos, Arturo & Benbunan-Fich, Raquel. (2018). Digitalization of Land Records: From Paper to Blockchain.)

Potential of disruption by Blockchain

Core Benefits:

1. **Immutable and Secure**:

It is nearly impossible to make changes to a blockchain without detection, thus greatly reducing chances of fraud. This is one of the biggest problems faced with the land registry and this would be solved by one of the strongest powers of Blockchain that is immutability. This would help in creating a land title/transaction record or ledger, the ultimate source of truth for this data be it a the regional, national or the international level.

2. Reliable and Available:

Since thousands of nodes share a blockchain, it has no single point of failure and is thus resilient to attacks. This is a great advantage over the traditional databases which are used by the Government to keep a track of land records and transactions. These centralized databases have a single point of failure which can fail due to many reasons including but not

limited to - power failure, network failure, manual error, natural disaster, etc. In a blockchain, the availability and reliability are close to 99% and higher as all the data stored in the blockchain is replicated across hundreds and thousands of nodes/computers resulting and a very resilient Disaster recovery and very high availability and reliability of the data stored in the blockchain.

3. Transparent:

Transparency is very powerful in the sense that it builds trust and combined with immutability, helps in building a source of truth in the ledger. The consensus mechanisms provide the benefits of a consolidated, consistent dataset with reduced errors. Although only a fingerprint of sensitive data is stored in a public blockchain ensuring security, the entry of that data the history of that data is transparent and can be accessed and verified by anyone using the blockchain. For the land registry, all the entries of land title data fingerprint and its history can be viewed in the blockchain ensuring that the data is transparent.

4. Saves costs:

Since there is no third party or intermediary (banks, legal institutions, government) involved, blockchain can cut down costs. One of the biggest reasons for the disruption of a particular use case or a pain point with the help of blockchain is getting all the powers of blockchain with minimal cost. The current land registration process is expensive to both the taxpayer and the Government which can be vastly reduced with the help of blockchain.

5. Near real-time:

It provides unbroken and timely records of information. Lack of a third party or intermediary also helps greatly in cutting downtime. The current land registration verification process takes weeks or even months to complete, especially in developing countries. But these can be vastly reduced to a matter of minutes when verification is done with Blockchain as a source of truth. This makes land title/transaction validation time another great KPI improvement with the use of Blockchain thus furthering the disruption.

6. Irrevocable:

It is possible to make records irrevocable, which can increase accuracy and simplify back-end processes. This can greatly help with respect to Land registrations as the fingerprint records inserted cannot be reversed.

Benefits in the Land Registry Domain:

1. A decentralized, standardized system for land registration records could reduce the number of intermediaries required, increase trust in the identity of transacting parties, increase process efficiencies, and decrease time and cost to the process.
2. Recording property rights via blockchain would enable annual cost savings for title insurers through a tamper-proof ledger.
3. Blockchain-based traceability will bring ease to the judiciary and help settle most of the property-related civil cases in Indian courts.
4. Blockchain technology would reduce lead times and expedite the registration process.

Business Benefits:

1. Near real-time visibility into the status of land with access to complete and permanent transaction history. Data science and ML techniques can be applied on this data as well.
2. The average time taken to process land transactions is reduced by half.
3. Around 33% reduction in administrative costs by eliminating manual processes.
4. Possibility to extend the validations via the blockchain to a third party
5. Elimination of the need to store physical archives of land records.
6. Enhanced data security and authenticity of land records renewed the confidence of buyers in the land registry system.

Extended Benefits:

1. **International Land Conflicts:**

This blockchain use case can be extended internationally to a global space as well. Land near the international borders, especially those which are disputed could be finalized after an agreement between the governments and embedded in the blockchain. Once the land titles or an international land transaction is embedded into a public blockchain after agreement from the participating nations, then this data can be used as an ultimate source of truth for this land.

2. **Faster and cheaper International Land Transactions:**

Similar to the above point, if any country wants to participate in a land transaction or a deal with another nation, the transfer of land title and the transaction can be embedded in the blockchain which would then act as the ultimate source of truth. This can be achieved in a very short time span after all checks are done and would also require a minimal cost.

Limitations

Some land is not registered:

The proposed model won't be able to be completely beneficial in areas where a lot of the land is not yet registered in the government's databases. This would include the tribal lands and the conflicted lands as well. To have the fingerprint of this data on the blockchain, the rightful owner would first need to be correctly identified and once all government related checks and registrations are done then all the data would be entered in the centralized government database and the fingerprint of that data would be entered in the blockchain.

Some countries have conflicted lands:

In India's case, there is some land that is disputed with China. Both the nations believe that some piece of land near the Doklam area belongs to them which sometimes results in minor conflicts and army standoffs between the two regions. Since there is no ultimate source of truth on the rightful owner of that land, the land title fingerprint data cannot be entered into the blockchain as there is still conflict on the owner.

Conclusion

We can conclude, that to accelerate the world to move towards Web3.0, it is best to implement blockchain based solutions which would be disruptive in nature. Due to the fact that many people and governments around the work are still skeptical to Blockchain and its powers, a good and efficient blockchain solution having a big impact towards solving a problem would help in getting more acceptance and recognition from people and governments around the world. Land registration is a big pain point from both a cost and time perspective for nations (especially developing nations) all around the world and the biggest features and powers of blockchain - transparency, immutability and decentralization can act as the best fit for the pain points for this use case.