IMPLEMENTING LAND RECORDS AND REGISTRATIONS USING BLOCKCHAIN TECHNOLOGY – CASE FOR E-GOVERNANCE

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Abstract
Technology landscape is changing rapidly and it has presented various tools that have potential to change the way we interact and transact. One of the recent developments has been the introduction of blockchain technology. Thesuccess of this is widely acknowledged in the implementation of digital currencies (Bitcoin being the pioneer and many have followed). The potential of this technology is not limited to digital or virtual currencies alone. Many evangelists and experts are predicting in unison that this is the next big thing after the internet and will impact all areas of modern life.

Don & Alex Tapscott, authors Blockchain Revolution (2016) says:

"The blockchain is an incorruptible digital ledger of economic transactions that can be programmed to record not just financial transactions but virtually everything of value."

There has been a steady progress in implementing commercial and enterprise grade applications using blockchain. In the early stages, innovators, startups and consortiums envisaged solutions that required development of a completely new platform or '(universal) blockchain' itself. This is a humongous problem to address, just like the internet itself. It cannot be solved by a single person or organization. For the right reasons, most 'blockchain' protocols are thus being worked by consortiums or through open source development.

While many applications were identified and catalogued for implementation, the standards and protocols are not fully ready and are being designed simultaneously. This has led to far fewer success cases than industry expectations.

Thus, for now, the attention has shifted more towards using an existing blockchain protocol and building applications by leveraging them. This shift is vetted by technology investors who are now looking for convergence of various technologies that have blockchain as one of the components within but not an end product itself.

In this paper, the authors' attempts to describe a problem area where blockchain can help provide a solid foundational solution in the area of e-governance. The use-case described is the management of land-recordsin the context of India.

***Keywords: Blockchain, land-records, asset management, virtual currency, e-governance, GoI.***

Introduction to Blockchain
A high level explanation of what is a blockchain is given below. The virtual currency explanation provides a basic understanding of blockchain. A real-life use-case of commercial application is also described.

Technically, blockchain is a database with its own unique architecture and protocol that makes it like an internet-based computing system. It differs from the traditional cloud computing models:
- Correctness of data and transactions is determined by mathematical (cryptography) proof of computation
- All transactions are chained into blocks; every new transaction and consequently its block have codified information of all its previous transactions and blocks;
- Consensus among parties and independent nodes is pre-requisite to add transactions to blocks;
- The blockchain thus formed is distributed as 'digital ledgers' to various stakeholders. The exact same data is available in real-time to everyone accessing it.

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Typical elements of blockchain architecture in a virtual currency called Bitcoin (BTC), to explain nuts-and-bolts and technology of blockchain techniques it uses to provide a distributed virtual currency.
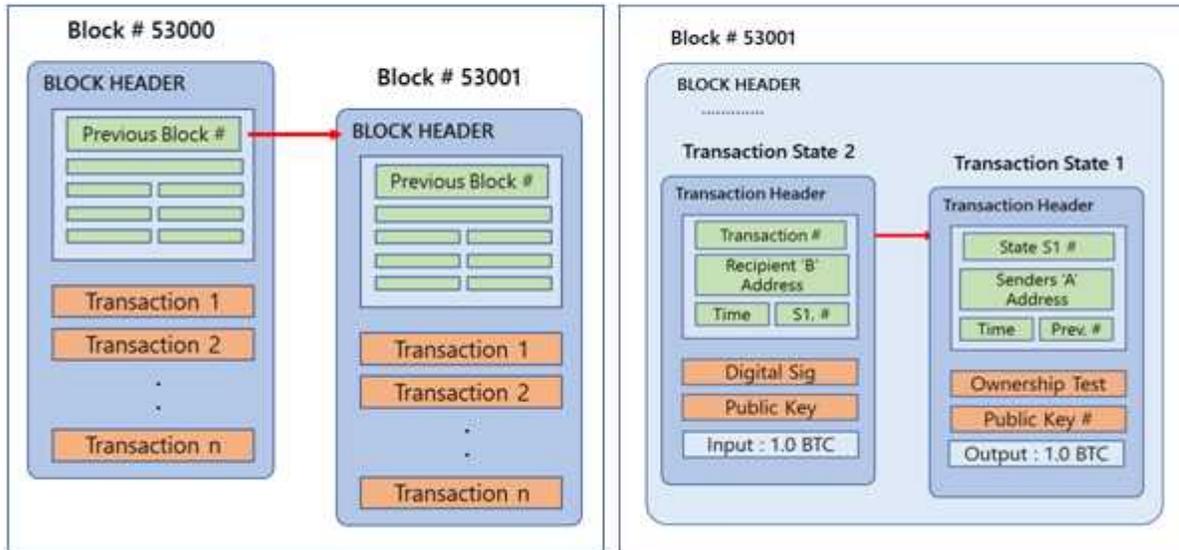
Virtual Currency Explanation
Typical Transaction: A pays 1.0 BTC to B:
1. This transaction will take place if
   - 'A' is the legitimate owner of the transaction and had previously received 1.0 BTC
   - Total available BTC in 'A''s account across multiple transactions is more than or equal to 1.0
   - State of the transactions allows 'A' to spend the BTC
2. After above checks:
   - A new transaction is created with 'B' as owner of 1.0 BTC. The transaction references the hash of the originating transaction
   - Transaction is identified by unique address of 'B' and her Public key
3. Change the state of Sender's original transaction indicating it's spent and 'A' is no more the owner of 1.0 BTC
4. Change the state of Receiver's transaction indicating the transaction is unspent and 'B' is the owner of 1.0 BTC
5. Move transactions to a new Block

The key take-away from this technique is that the ownership of BTC is unambiguous, mathematically proven before any transaction is approved.

Real-World Analogy
So how does this translate to a commercial application with an entirely different use-case – other than virtual currencies? Let us examine digitization of land records using block chain.

Think of an ideal registrar's office in a smart-city were we have a digital ledger (like full blockchain data). The ledger has real property document of every person in that jurisdiction. It contains information back to the beginning of recorded history, organized chronologically, indexed and digitally signed by current owners. There are many such offices within the smart-city limits – each having the same shared copy of the ledger, such that:
   a) Records are incorruptible, immutable and cannot be duplicated
   b) Records once set chronologically cannot be changed in time
   c) Have irrefutable unique digital signature establishing the true ownership
   d) Are decentralized but permissioned and regulated without human discretion
   e) And get same answers to questions raised and services offered at all offices

It is evident that the basic building blocks used in virtual currency also applies to other commercial applications. At a high level, blockchain for land records seems to be one of the many problem areas that any government can implement. The larger point is that use-cases may change but the underlying problem statement and the solution offered in principle remain the same.

Digitization of Land Records

The analogy is clarified further in the detailed solution section.

Given the introduction, we now look at the severe problems in current land record management systems and how blockchain would solve those problems. In subsequent sub-heading we will tie them back to the proposed solution.

- **Undeclared/ Laundered Money**: It's in common knowledge that hoarders of money/value convert a large part of their undeclared income or cash into assets - land property being most popular. GoI needs to take multi-pronged approach to tackle this issue. The recent decision by GoI to demonetize higher value currency notes to combat black money menace is akin to starting new transactions on a clean slate. However, further systemic reforms are needed to ensure that the menace is eliminated at the seed and doesn't resurface again.

- **Legalized Land Records**: Action taken by GoI that is widely appreciated and discussed is Benami Transaction (Prohibition) Amendment Act, 2016. This is a big legislative step to curb channeling of undeclared income into property transactions and streamline records. GoI,however, needs to strengthen the systems simultaneously to reap its long-term benefit.

- **Dispute Resolution**: Civil disputes are estimated to be over $1/3^{rd}$ of the total pending judicial cases (estimated 2+Crores). Another study indicates that over $2/3^{rd}$of all civil cases are due to illegal possession of property, title disputes, contractual disputes etc. The staggering number of pending cases has put undue stress on judiciary and raised cost of transactions significantly. GoI needs systems in place to increase certainty in land records for a quicker resolution at a lower cost.

- Primary root cause of most of these seemingly disconnected problems is human discretion. Rules and regulations are introduced by government to reduce such discretions, which in turnincreases complexities in processes which over time leads us to rely on discretion.

A smart systemcan break away from this cycle and provide a long-term solution.

The Visible Problems (Ground Level)

The high level problem statements manifest itself at the ground level in different ways. Consider the context of India and its massive land area and 1.31 billion populations.

There is need for better managed records. But the following issues compounds the problem statement:

1) Land Record management has gone through several changes post-independence. It differs from state-to-state and sometimes with local influence within a state
2) Records-of-rights (RoR) are maintained in Tehsil office and updated infrequently
3) RoR: Textual document dealing with ownership, occupancy, tenancy, crop inspection register, mutation register, disputed cases register, etc. There records are not connected systematically, thus prone to errors during newer transactions.

Land record maintenance procedure is itself riddled with problems

a) Sanctity of record is maintained by 3-4 standalone agencies. Record updated in one department makes it outdated in other department(s)
b) Transactions of land are recorded but the ownership titles remain presumptive, giving scope for fraudulent transactions like double-sale, sale by non-owners, buyers with no firm ownership (benami), back-dated transactions etc.
c) About 20% of disputes in various courts are related to illegal possession of property, title disputes, contractual disputes etc.

The thread that we will explore more is the nature of ownership of land records. We will further examine both aspects of solution viz., process & technology.

The Process Solution that's Already Underway

Central and State governmentshave taken initiatives to resolve some of these large procedural issues. Success though limited but nonetheless very encouraging.

Some of the Initiatives

National Land Records Modernization Program (NLRMP) 2008.

Earlier initiatives, Strengthening of Revenue Administration (SRA) and Updating of Land Records (ULR) had disadvantages as they didn't conform to modern schemes of survey, registration and maintenance. These were overcome by NLRMP:

Computerized Land Records

- Data entry/re-entry/data-conversion of textual records including mutations and other land attributes
- Digitization of maps, integration of textual & spatial data

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- Tehsil, sub-division/district and State-level data centers
- Connectivity/linkage with central server at state capital
- Survey/resurvey and updating of the survey & settlement records using GPS

Computerized Registration Process
- Computerization of the sub-registrar's offices (SROs)
- Data entry of valuation details, legacy encumbrance data, scanning & preservation of old documents
- Connectivity to Sub-Registrar offices with revenue offices
- Modern record rooms/ land records management centers at tehsil/taluka/circle/block level

Some of the key laudable results are shown in table below:

Status of NLRMP program as on 2014	Total Number of states
RoR data entry completed	13
RoR data entry likely to be completed soon	6
RoR data entry started but not completed	10
Still at preparatory stages	5
Stopped manual issuance of RoR	8
Placed RoR data on website	6

These initiatives have laid a good foundation to resolve the problems and strengthen the systems of land-records.
Can we improve upon this further? Can we convert land record/registrations into digital assets that:
- Are incorruptible, immutable. A land sale deed or transaction once entered in the system shan't be changed in any ad-hoc manner even by persons with administrative rights
- Cannot be duplicated.A person in collusion with authorities shan't create multiple legitimate transactions for the same record, dubiously
- Have irrefutable unique digital signature of all individuals involved in the transaction (even from the society's lowest strata)
- Are decentralized and available to public on need basis while not revealing sensitive information

Some pertinent examples:
a) Person interested in buying a property could look-up its status (chargeable service)
b) Person can know if it's disputed or under the ownership of the person claiming to sell it
c) Authorities can verify the authenticity of records and issue genuine certificates
d) Initiating officers, Approving authorities, Administrators and Adjudicating authorities have reliable, real-time data to quickly settle disputes and set the records straight

Answer is categorical yes for all-the-above and is described in the technical discussions below.

Digitization of Land Records Using Blockchain
Technology Solution (High Level View)
So how can the blockchain technology be leveraged further? The current initiatives provide us with a good starting point. Computerization of land records, upgradation of Tehsil/Registrar office is work-in-progress, which can and must be leveraged to build a layer of systems that uses blockchain protocols.

The framework of solution is shown in the diagram below.
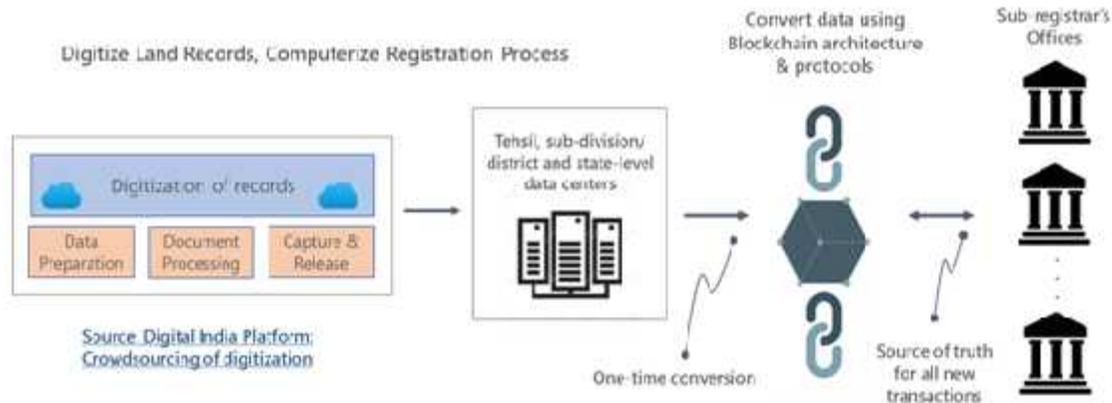
We are proposing these steps for implementation:
1. Convert all the historical land-records into a blockchain as a one-time activity.
2. Use the blockchain as the source-of-truth for all subsequent transactions.
3. Implement these in multiple phases.

Technology Solution (Ground Level View)
This diagram attempts to explain the (envisioned) blockchain solution by linking it back to the analogy of Bitcoin described in the Introduction section.

Note: 'L-'prefix is intended to clarify that this is a land transaction (sale, purchase, transfer, etc.)
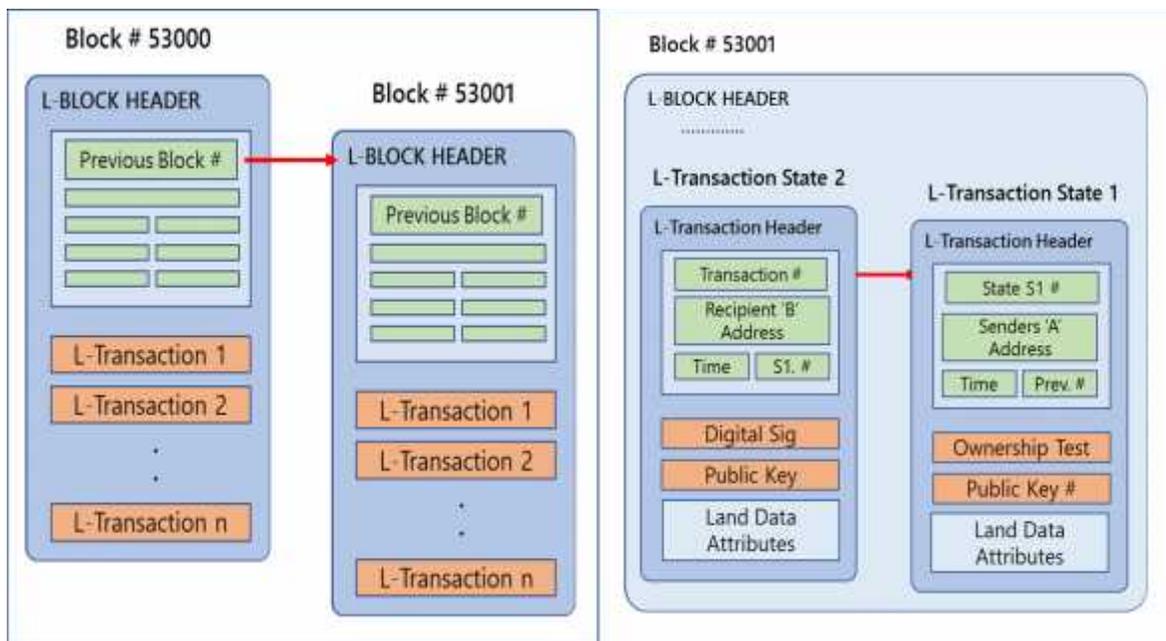
The single most important change between the two protocols is 'Input/ Output'. In Bitcoin, it's the value of **currency token** (BTC). In proposedcase, this would not be a single token but combination of important attributes of land-records. It's obvious that using the Bitcoin-blockchain base is not sufficient to achieve it. However, there are blockchain that have built-in smart-contract functions that may be used to define and manage '**land attributes**'.

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Sample set of land attributes:
- Survey#, Plot#: key attributes maintained/cross-referenced across departments
- N/E/W/S of plot: physical identification of land
- Khata#: manual ledger for records
- Taluk, Dist, State: physical address
- Lat-Long: GPS latitude and longitude
- Classification (Green/Yellow/Purple/Black/etc.): identify governing authority
- Owned by entity: identify governing entity

Sample set of ownership attributes:
- Name:Of person/ department owning the land
- Address: communication address
- ID (PAN/Aadhaar/etc.):Unique national identifier
- Last Sale Deed:Contract held by person forland ownership
- Transaction Date:Contract Date

The digitized land records (DLR) thus created would become 'single-source-of-truth' for all stakeholders: consumers (public), revenue/sub-registrar/DC office, Tehsil/Sub-divisions.
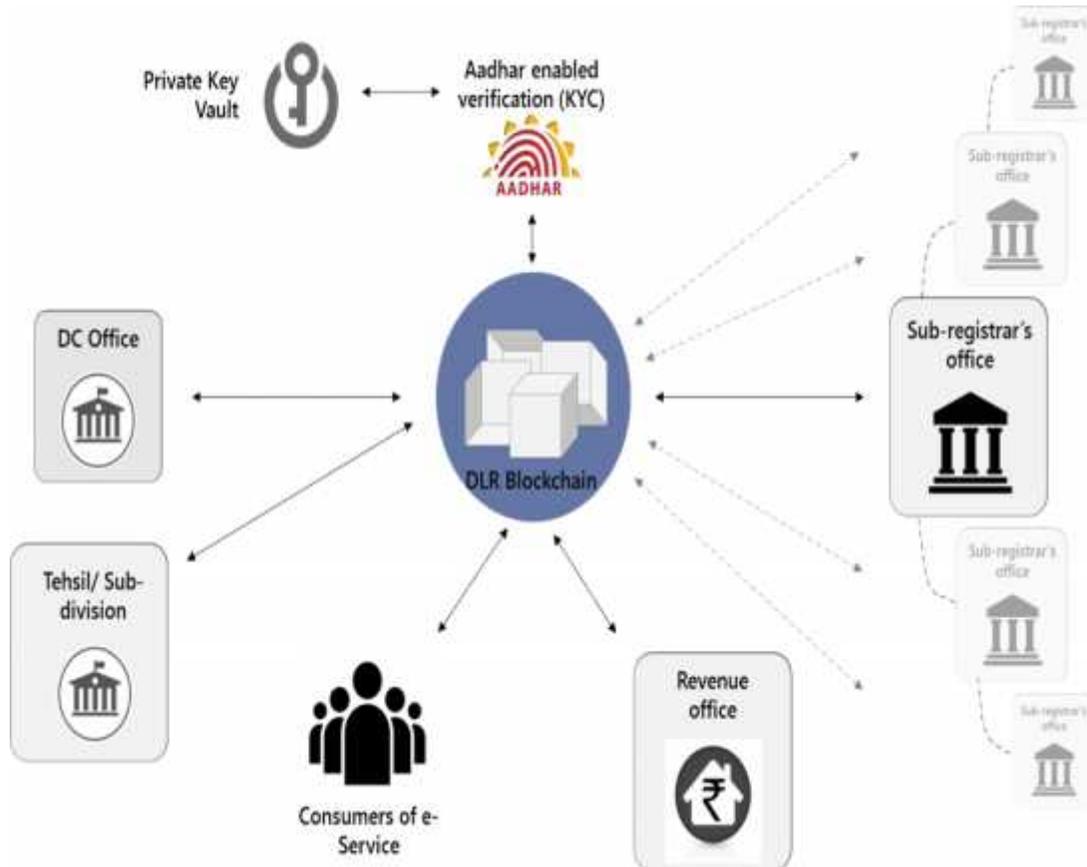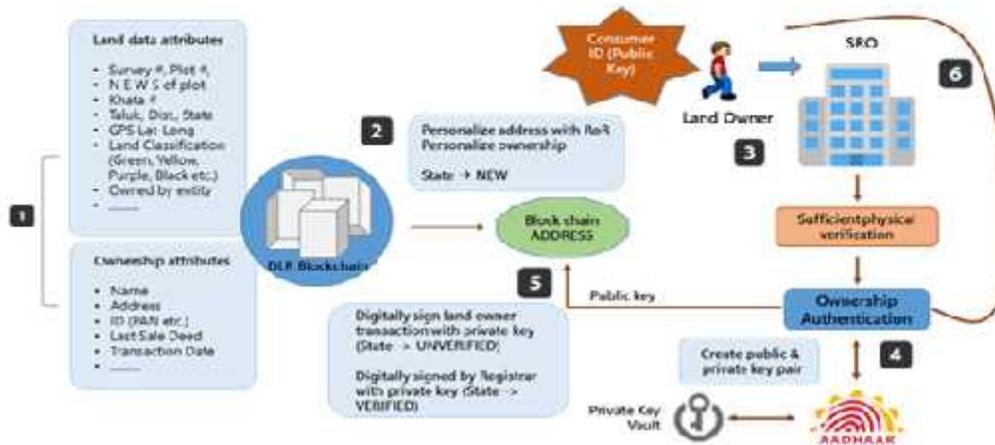

One of the important entities that could add to the transaction security is:
Aadhaar as Authentication Mechanism
In any blockchain, the key to establishing ownership is the use of cryptography. The vulnerable part of this is the storage and access of users' private-key. Any compromise to this would lead to severe consequences. We have a potential solution in form of Aadhaar enabled verification, to access the private-key vault. The method/wayof its usage is shown in below diagrams.

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Converting existing land records into a blockchain

1. Identify and migrate important & required attributes (Land data, ownership etc.) from credible government source to DLR blockchain.
2. The blockchain record will hold RoR (Records of rights) as per government records but with state as NEW
3. The owner visit SRO to establish the ownership of right in person and property documentation
4. The owner ship by Aadhaar verification process is initiated and public-private key is generated using a secured vault
5. This public key is sent to blockchain and owners digital signature is recorded and state changed to UNVERIFIED
6. State changed to VERIFIED post digitally signed by registrar with his/her private key (again using Aadhaar verification process)
7. Post Aadhaar verification process, owner is provided with Consumer ID (public key) for all future transactions/verifications

Using the blockchain to do all subsequent transactions

1. The seller with his/her Consumer ID (public key) establishes the ownership of the property by Aadhaar verification process.
2. The potential buyer initiates the verification process to buy the property with his/her Consumer ID (public key)
    3. In case the buyer is new to the system, submits KYC to SRO. Aadhaar verification process is initiated and public-private key is generated using a secured vault
    4. Is provided with Consumer ID (public key) for all future transactions/verifications
5. Both the seller's and buyer's authorization is done in the blockchain record
6. The blockchain record is updated with buyers address and digital signature and the state is changed to UNVERIFIED
7. State changed to VERIFIED, post digitally signed by registrar with his/her private key (again using Aadhaar verification process)

Technology Solution (Next Steps)

Compared to Bitcoin blockchain, certain blockchain properties makes it applicable for large number of enterprise/e-governance use-cases. The feasibility of building such an application over blockchain would require many technical considerations. Given is the in-exhaustive list:

- Virtual Currency/Token: is necessary?
- Supports Smart-Contracts?
- Properties of a blockchain protocols
    a) Turing Completeness
    b) Value Awareness
    c) Multiple States
    d) Open to integration with other blockchain
- Permissioned vs. Permissionless blockchain
- Public vs. Private vs. Regulated access
- Manage large dataset
- Support easy conversion of initial data

Once these are examined, it would be necessary to choose suitable blockchain from existing solutions. It's not recommended to build a new protocol altogether for reasons discussed previously and many blockchains are in place tackling one or more considerations. A suitable milestone could be a detailed white paper with a comparative analysis of various industry blockchains, which could also flesh out the solution in greater detailfollowed by Proof-of-concept demonstrating a limited capability Lite solution.

Benefits of the System
Hypothetical Use-Cases
Overcome Double Sale

Krishna owns an ancestral land in suburbs. He is under debt and sells his property to a potential buyer Viru, who is non local resident and seldom visits the place. Sometime later, Krishna wanting money, decides to sell this property dubiously to another buyer Gopal. He presents old documents of the property and in collusion with local agent completes the second-time sale. On his visit, Viru is surprised to see Gopal's name board on the land.

Krishna was able to make double-sale as the ownership of the title wasn't unambiguously verified. In fact, Krishna could sell it multiple times asvarious disconnected systems have only presumptive ownership of the land.

With blockchain system in place, the first transaction would record the digital signature of Viru. If Krishna intends to sell again, he would not pass the ownership test in blockchain. The second sale to Gopal would be automatically blocked

Managing Disputes

Ramanna is new in City, wantingto buy property. He sees a land with a value significantly lesser than market price. The property paper indicates it belongs to Chenappa, who purchased it from Shiva, who inherited it from his deceased father. Shiva's brother has filed a case as he has equal right of ownership. Chenappa is aware of this disputeand wants to dispose the land ASAP.

Without proper authentication system, Chenappa can successfully sell the property to Ramanna. Ramanna would know of dispute when he gets entangled in the legal battle, further complicating the judicial case.

With blockchain system of records, the state of the property could change to DISPUTED as soon as court admits the case. When Chenappa tries to sell, the verification step would STOP property transfer. Post dispute resolution, state would be changed to VERIFIED and property ownership is recorded as per court's decision. This land/asset is then eligible for next transaction.