

Digitally Secured Mother Document Using Block chain

M Nithya - ¹Assistant Professor ,Sri Krishna College of Engineering and Technology
Department of Computer Science and Engineering

Arun kumar M - ² UG Student Sri Krishna College of Engineering and Technology
Department of Computer Science and Engineering

Abishek M - ³ UG Student Sri Krishna College of Engineering and Technology
Department of Computer Science and Engineering

Arullamudhane L C - ⁴ UG Student Sri Krishna College of Engineering and Technology

D.Srivaishnavi - ⁵Assistant Professor ,Sri Krishna College of Engineering and Technology
Department of Computer Science and Engineering

Article Info

Volume 83

Page Number: 9678 – 9687

Publication Issue:

May - June 2020

Abstract:

The birth of Blockchain technology in the style of Bitcoin, has triggered a large interest by demonstrating the likelihood of eliminating would like the necessity of the requirement of need of an intermediary and revolutionized the interactions between folks and machines by increasing trust. ab initio restricted to the domain of cryptocurrencies, people started realizing the potential of technology to travel on the far side simply cryptocurrencies which are a crystal rectifier to the adoption of blockchain technology to resolve real-world eventualities. One such situation is that the issues in E-governance systems among the general public domain sectors. For the scope of this paper we have a tendency to in the main centered on the issues in Land record and revenue sectors. In this paper, we have a tendency to analyze the mixing of blockchain technology to the prevailing business processes and in doing so, we have a tendency to address issues like knowledge integrity, privacy, and a lot of significantly the dearth of common platforms between the organizations concerned. The evolution of blockchain technology crystal rectifier to the introduction of permissioned blockchain platforms, Hyperledger cloth could be a leading permissioned blockchain platform that is employed within the development of our project. Finally the target of this paper is to gauge the performance of blockchain based implementation of a land revenue .

Article Received: 19 November 2019

Revised: 27 January 2020

Accepted: 24 February 2020

Publication: 18 May 2020

I. INTRODUCTION

Technology in its relationship to world changes has perpetually been at the forefront to disrupt the establishment and produce a new recent perspective to appear upon the items. Once it involves the general public domain connected industries, the technological changes typically find themselves entangled with the policy rules and are given with an excellent deal of difficulty whereas scaling up. One such example is E-governance and above all

Property Registration and Land Records Management. During this thesis, we tend to go deeper into the understanding of the on top of example whereas conferring it to the Indian Context and therefore the existing issues related to it. The most purpose of this paper is to assess whether or not group action with the blockchain technology could be a sensible answer or not. we'll look into the properties of blockchain technology that produces a fascinating answer for the prevailing issues and

finally we'll present you the results obtained throughout performance analysis of the system enforced.

Land Records and Titles

One of the most important challenges that grip numerous states in Asian nations is the issue of Land possession, that is in part because of the actual fact that there's no end-to-end effective Land records management system until date. The difficulty of Land possession is therefore vital that nearly establishments heavily rely upon the possession of the Land-based properties for collateral security. Because of the uncertainties on the possession claims, it becomes additional sturdy for the sturdy establishments to operate properly with ease and so hampering the expansion of the nation. "Land possession in Asian nations is presumptive." Land possession in Asian nations is principally established via the sale deeds (procured throughout the property registration) and a few alternative documents. However, of these documents don't guarantee the claim of possession however rather establish the actual fact that a transfer of property has been recorded and these recorded transactions square measure what we tend to decision a "Land Records". The word "Land records" itself may be a generic expression and may be a end result of the many alternative documents providing numerous alternative info like property maps, Record of Rights (ROR), sale deeds et al and these square measure maintained across different departments. Because of the poor maintenance and also the lack of communication across the departments, we tend to fairly often fairly often, superannuate and information being out of synchronization in Land Records. These discrepancies square measure the foundation reason for possession drawback in concert and have to return many years of records to verify the possession claim.

Digitization of Land Records

The need for clear titles and conclusive land ownerships are fairly elaborate within the previous section. So over the last 3 decades, numerous schemes are enforced in Modernizing the land

records to maneuver towards a clearer and conclusive land possession from the presumptive property titles. we have a tendency to aren't go deeper into the main points of however modernization has been enforced and for the aim of this thesis, we have a tendency to assume that the land records area unit is utterly digitized.

II. LITERATURE REVIEW

I. CURRENT BUSINESS PROCESS OF LAND REGISTRATION

In this chapter, we describe the current scenario of the property Registration and the transfer of land in the Indian context and in particular for the state of Uttar Pradesh. We found that almost all the states in India have more or less adopted the same kind of the workflow, so we can assume that the findings we provided for the state of Uttar Pradesh can be extended to other states as well. We found that in almost all the states of India usually two or three departments handle the Land related documents [10] and they are given as follows.

1. Department of stamps & Registry (DoSR): It handles the verification of documents during the registration of a transfer. It also has the added responsibility of collecting the stamp duty of the sale deed to be legally recorded.

2. Revenue Department or Board of Revenue (BoR): It handles the preparation and maintenance of the Textual Records or the transaction details

3. Survey and Settlement department: It handles the preparation and maintenance of the maps.

Department of Stamps & Registry

The DoSR currently handles around 62 different types of deeds over various domains such as transfer of immovable property, Marriage registration and bond papers etc. For the purpose of this paper, we confine ourselves to the deeds related to the Land/Property Registration.

Given below are the different kind of possibilities in which you can acquire immovable property in India:

- Property inheritance
- Through Will
- Purchase of the property
- Government or court will grant the

Property.

Each of these above transactions go under different types of deeds and thus divide in their work-flow. For this thesis, we will focus mainly on the registration of property acquired via purchase.

The Sub Registrar office is the place where all the registration work takes place and has maximum interaction with the public. The various responsibilities of the office are listed below:

1. Estimation of property value
2. Collection of stamp duties
3. Registration of sale deed
4. Preservation of copies of sale deed
5. Issuing certificates of the registration

Under the registration act of 1908 [11], all the transactions that involve the sale of any immovable property have to be registered, thus ensuring all the information on the transactions is valid and maintained. Although the introduction of online portals have their advantages in the form of increasing transparency in the evaluation of properties, it has not completely replaced the manual intervention where at stages, the user has to be manually present at the SRO for authentication purposes.

Given below are the steps during the registration of Immovable property in Uttar Pradesh:

1. Verification of the Property: This side of the registration usually lies with the customer to own a radical check on the title of the property. As earlier mentioned in chapter one the land titles in India have tons of inconsistencies and therefore the transition to the web portals haven't however repaired the issues that the vexation is on the customer to verify the past ownerships of the property.

2. Property price Estimation: Estimation of property price has got to be worn out in order to pay money for the taxation for the registration, which can be calculated as a proportion of the circle rate within the space.

3. Preparation of stamp papers: Non-judicial stamp papers admire the worth of the taxation area unit to be bought that area unit currently created out there on-line

4. Taxation payment: This half will currently be done via on-line portal

5. Registration at the SRO: This a part of the registration method needs manual intervention at the SRO for the authentication of the customer, trafficker at the side of the witnesses.

Board of Revenue

As mentioned earlier, within the state of province the BoR deals with the preparation and maintenance of the group action details. The duties of the department differ greatly with the situation of the immovable property i.e whether or not the property belongs to associate degree urban class or rural. Within the case of the former the transfer of immovable property ends with the preparation of sale deed and therefore the details of the group action are recorded at the town the town, and therefore the sale deed acts because of the title document. Whereas within the case of the latter the BoR has some additional responsibilities of corroborating the transactions and just in case of any disputes a revenue court is controlled. There are around twenty two documents maintained by the BoR which may be thought-about because of the term "Land Records". The opposite vital task undertaken by the BoR is that the mutation proceedings of immovable property. therefore mutation, because the name suggests, refers to the amendment within the possession of the property within the BoR records and that we cross-check the 2 main potentialities during which a mutation will happen.

1. Succession: As earlier mentioned within the on top of section, we've checked out during which you'll get associate immobile property. The cases of property inheritance and thru can come beneath the Succession class.

2. Transfer: The transfer of property via purchase is another class during which a mutation continuing is initialized. although there are several alternative potentialities of initiating a mutation continuing, during this thesis we tend to confine ourselves to the top of 2 mentioned classes.

Need for a Blockchain based platform

Over the course of this chapter, we have a tendency to elaborate the assorted responsibilities of the departments concerned and also the procedures of transferring AN stable property. During this section, we have a tendency to list out the issues within the existing resolution and within the method of doing so, we have a tendency to argue why we predict blockchain may be a sensible resolution to those issues. Despite the digitisation of land records the prevailing method still faces several issues and security threats. we have a tendency to believe that the subsequent square measure is chiefly accountable.

1. Centralized Architecture: We have already mentioned regarding the transition to the digital records and also the on-line portals that have inherent existence over time. However the vital factor to contemplate is that every one these transitions mentioned, work below ancient centralized databases. In any centralized information, the design is comparable to a hierarchical pyramid wherever folks up the chain are in a very position to abuse power. These styles of power abuse by design or accidentally could also be could also be general as Associate in Nursing business executive Attack.

In data security, business executive attacks cause a more durable downside to be handled, as a malicious business executive is just too well hidden to be detected by ancient ways. There's a well known argument that victimisation corrects work mechanisms the business executive attacks will be detected. we tend to believe that with all the applications looking forward to a centralized design, even the work mechanisms any worker with admin privileges will attack the system and even corrupt the work mechanism creating him/her untraceable. This over-dependence on the normal centralized

design is what blockchains aim to forestall. Earlier within the section a pair of.1, we tend to mention the vital properties of blockchains are decentralization and also the immutability of knowledge and that we believe that these properties will actually facilitate forestall the sooner mentioned attacks of a centralized design.

2. Integrity of data:This shows the accuracy, consistency and completeness of data, it's the reassurance that the info we have a tendency to square measure accessing is ascribable, legible, contemporaneously recorded, original and correct typically brought up as ALCOA

(a) Attributable: knowledge changes ought to be traceable i.e if knowledge is modified then why and WHO ought to be answerable for the changes.

(b) Legible: knowledge should be recorded for good in an exceedingly clear manner

(c) Contemporaneous: Recorded knowledge ought to be followed by the days

Tamps

(d) Original: The recorded knowledge ought to be original and not a certified true

Copy

(e) Accurate: Modification of records mustn't be allowed while not correct documentation and authorization additional typically than not in ancient centralized info systems, the integrity of information is usually not maintained i.e we have a tendency to don't have absolutely the certainty that the info being shown on the applying is really the info that has been recorded originally. We've earlier seen that the blockchains square measure changeless, distributed ledgers and therefore the transactions that square measure once recorded can't be modified. conjointly the distributed design of the blockchains helps in preventing the unauthorized modification of information via accord mechanisms.

3. Trust in cross-organizational workflow: We've seen that in an exceedingly property transfer, each the department's square measure concerned. They work on this shared knowledge as an example in mutation proceedings of a property. More usually than not, these departments add silos and therefore the knowledge that's being shared across isn't being properly updated and therefore results in lack of trust between the organizations. The public blockchains not being appropriate in an exceedingly cross-organizational appropriate thus we have a tendency to believe that a blockchain three.0 platforms cater to the on top of wants utterly.

4. Public verifiability: Throughout the preparation of sale deed within the DoSR, we've earlier mentioned that the encumbrance is on the client to possess a radical verification of the property title. Even after the conversion of the records, they usually appear to be out of set or not up to this point. This can be in part because of facts that the present system is at risk of corporate executive attacks or because of the dearth of trust between the parties concerned. Because of these discrepancies, the client has to return to many decades of documents to verify the property titles and such a method is extremely inefficient. If the blockchain technology is with success integrated to the present method, the general public verifiability simply gives mistreatment the scientific discipline hash properties of the transactions and therefore the hash linkage of the blocks is accustomed to provide the traceability of a specific record.

III. PROPOSED SYSTEM

In this chapter, we are going to look at the design and implementation details of the Hyperledger Fabric integration to the existing process of land record maintenance & registration.

Design

In this context of hyperledger , An analogy will be drawn between the departments concerned within the organizations and existing methods in an

exceedingly material network. We all know that in material, the ledger is related to a state decibel sculptural around assets and a dealing log. this will be wont to serve the role of the info within the existing design. Chain Codes put in on the peers may be wont to modify the ledger information, therefore mimicking the functionalities of ancient info applications.

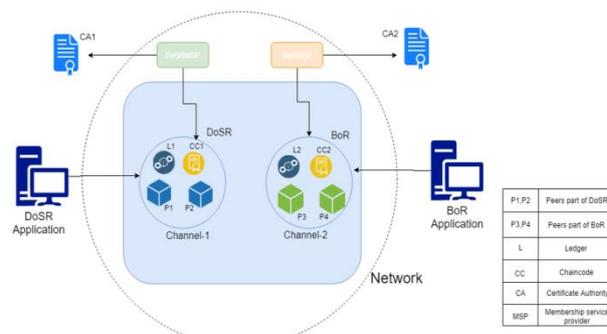


fig 1 : Initial design architecture

When we tend to talked concerning the issues within the existing design we mentioned that the information Integrity and also the gaps within the cross-organizational appropriate ar the main ones. By modeling the whole information on a ledger, we tend to ar making certain the integrity of the information as we all know from the properties of the distributed ledger technology, the information on the ledger is immutable and immune to immune to. We currently grasp that in a very hyperledger material network, every channel is related to one ledger and also the ledger will solely be accessed by the peer on an equivalent channel. Within the current business method, the BoR don't have any manner of communication with the DoSR as they're not connected and therefore there's no manner of digitally validatory sale deed submitted throughout the mutation method. This gap is bridged by transferring each of the organizations on one channel and by putting in the chaincode of DoSR on the BoR. we will verify the integrity of the sale deed.

SDK Layer

By putting in the chaincode CC1 on the BoR peer we tend to square measure implicitly permitting the

proof against the DoSR ledger information. To prevent associate degree authorization checks must be performed before invoking the chaincodes. In a material network, we all know that the shopper application sends a dealings proposal to the endorsing peers that invokes the chaincode. This interaction between the shopper application and therefore the material network sometimes happens through the Hyperledger material SDK. Currently, material has officially discharged support for 2 SDK for Node.js and Java. The identity of any shopper application attempting to invoke a chaincode are often accessed by mistreatment the SDK layer, which may be wont to limit the access and therefore prevent the proof against.

REST API Layer

In the earlier section, we've seen that the invocation of a chaincode happens through the material SDK. We've seen that within the context of Hyperledger material, the terms good contracts associate degreed chaincodes square measure usually used interchangeably however an SC refers to the dealings logic and multiple SC's are often concerned in an exceedingly chaincode. For each good go for the chaincode a corresponding operation for the invocation is defined within the SDK layer. to cover the main points of the good contracts to the tip user, a REST server is employed to reveal the endpoints of the SDK Layer.

Verity

We all know that blockchain technology is basically a distributed network of nodes maintaining constant state of the ledger. throughout this maintenance, the information|the info|the information} is replicated among all the nodes and with heavier data on the blockchain ends up in slower dealings speed. thus rather than migrating the whole info onto the blockchain, we'd like we'd like to safeguard the integrity of the info. Verity may be an informationless framework residing between the infobase layer (SQL DBMS) and therefore the blockchain network that claims to forestall the

extrajudicial meddling of knowledge all the whereas conserving the data privacy. For the aim of this thesis, we tend to assume that the centralized databases used at the DoSR and therefore the BoR are often classified as SQL database management systems. To use the prevailing info with the blockchain network we'd like to make a link between the prevailing tuple on the info and therefore the information held on on the ledger.

For every tuple within the database management system, information regarding the info tuple is formed. This created information (Cryptographic Hash) alongside the worth of the first key of the table is to the ledger. thus anytime a knowledge tuple is in rivalry, the subsequent steps square measure followed:

- information of the info tuple is formed
- Ledger is queried for the information of the tuple in rivalry mistreatment the worth of the first key
- Verification of each the retrieved information is completed. This suggests that no extrajudicial modification has been done to the database management system by circumventing the verity protocol.

Similar protocols for choose, INSERT, UPDATE and DELETE are provided by Verity .

IV. EXPERIMENTS

Working environment

Hyperledger cloth technology isn't however quite matured and plenty of releases of the technology are happening simply within the span of a few months. For the aim of this paper, Hyperledger cloth version one.4.0 has been used.

Technical Details:

- operative System: Ubuntu sixteen.04 LTS

Hyperledger cloth includes a list of pre-requisite softwares that requires it to be put in before beginning a network. throughout the course of this project, we have a tendency to found that not all versions of the prerequisites are compatible with one

another thus we have a tendency to ar listing the versions of the softwares employed in this project :

1. cURL v7.47.0
2. Docker v18.09.5
3. Docker-compose v1.18.0
4. Go v1.11.4
5. Npm v6.4.1
6. Node.js v8.14.0

All the necessary elements of the Hyperledger cloth like Peer, CouchDB, Ordering service are packaged into manual laborer pictures. Hyperledger cloth Samples provided by the community has the script to fetch all the connected manual laborer pictures from the manual laborer Hub and additionally the platform additionally binaries later employed in the network also are found within the Bin directory of the material Samples.

Backend or Network Layer

From the image of final network style in style five.4 we all know the design of the network and treading on the main points fastidiously we have a tendency to use the subsequent set of the network within the thesis project.

Anchor Peers: peer0.dosr.landrecords.com,
peer0.bor.landrecords.com

Now that the set of the network is determined we have a tendency to flip our attention to begin the network. For any cloth network given below are the list of steps to be dead to create the bottom of a network :

1. Generating crypto material: As explained in section four.4, Hyperledger cloth may be a permissioned network and every element within the network has an identity. The cryptogen binary provided by the material samples is employed to information all the certificates as provided by the set file that indicates the number of organizations, the quantity of peers related to every organization and alternative details that are mentioned in style half-dozen.1 earlier. All thecertified to be used for numerous functions are generated in

directory(cryptoconfig in our case). in a very real preparation a preparation authority has to be Used.

2. Generating Channel Artifacts: Within the case of our project, a pool of each organization with one channel connecting them is employed. The configtxgen binary tool is employed to come up with the to come up with for the channels and therefore the earlier defined anchor-peers within the network. ConfigurationFile (configtx.yaml) specifying the main points of the organizations employed in the network together with the pool details is employed as AN input to the tool. 3 different outputs ar generated during this section –namely:

- genesis.block
- channel.tx
- Anchor peer dealing files for each the organizations concerned

All the on top of files are placed beneath the directory channel-artifacts.

3. beginning the manual laborer containers: We've mentioned that each one the main components of material are manual laborer pictures. All the different elements of the network ought to be deployed in isolated manual laborer containers. A set file defining all the elements mentioned within the style half-dozen.1 together with their environment variables and alternative details are collected. Docker-compose will be wont to deploy these listed services into containers.

4. Channel Operations: Currently that each one the containers are deployed, we'd like to affix all the different elements to the network. Below mentioned is that the list of steps sometimes concerned in beginning the network:

- produce the channel
- be a part of all the peers concerned within the pool to the channel
- Update the anchor peers
- Install the several chaincodes on to the peers

Deployment

Every distributed system involves multiple nodes connected along via some network. Up as yet, we have a tendency to manage to deploy the Hyperledger cloth application in a very single machine. During this section, we have a tendency to discuss the preparation of the project on a multi-host setting. In a hyperledger cloth application major elements of the network run in isolated manual laborer primarily based containers. Just in case of runtime these containers ought to communicate, for one host setting channels will be used because the communication medium except for a multi-host design won't work. Thus we have a tendency to discern that manual laborer swarm4 with the assistance of AN overlay network will be wont to communicate between containers deployed across multiple hosts.

The nodes in a very dockhand, dock-walloper, lumper, laborer, manual laborer|labourer|Jack swarm clusters will be classified into manager nodes and worker nodes. The manager nodes are chargeable for making the services and have the management over the network whereas employee nodes receive and execute the tasks communicated by the manager nodes.

Network Configuration:

For the aim of this thesis project, we have a tendency to victimise seven virtual instances. sometimes in a very manual laborer swarm cluster the nodes ar sometimes victimisation their hostnames and that they ar and that they these terms for the rest of this paper. All the package stipulations mentioned within the implementation section half-dozen.1 together with the project code ar to be setup on every instance.

All the instances used are having Ubuntu sixteen.04 LTS as OS and half-dozen GB RAM. We have mentioned the different elements concerned within the network together with their details in style half-dozen.1. the subsequent topology is employed during this project to distribute the elements across the instances.

V. RESULTS AND DISCUSSION

Impact of Arrival Rates

We have earlier said that, just in case of Hyperledger caliper the benchmarking of a network is completed via batches of transactions committed to the network. for each blockchain network there's AN existing optimum turnout which might be handled, therefore if the arrival rate of a batch is way but the optimum turnout, every group action stays less time within the network decreasing the common latency of the batch, and if the arrival rate is above the optimum turnout, the transactions stay longer within the queue increasing the waiting time of the transactions and therefore increasing the common latency. therefore in-order to know of arrival rates and therefore the optimum turnout of the network, this experiment executes batches of transactions at different arrival rates. During this section, we are going to first conduct the experiments on the insert transactions and shortly the question transactions.

Insert Transactions

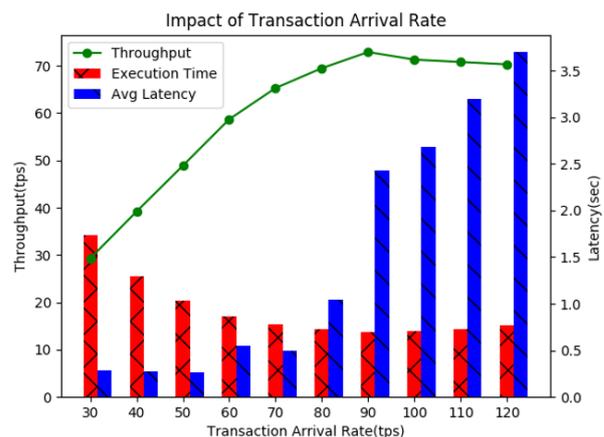


Fig 2 : Impact of arrival rates

With increase within the arrival rate the outturn of the network exaggerated Linearly till it reached associate best purpose, with an extra increase within the arrival rate the outturn remained about to the best worth. With arrival rates lesser than the best worth, the typical latency of the batch is significantly lower (in order of zero.2-0.6 sec) as a result of the

lesser waiting time for the transactions within the network. once the arrival rate simply crosses the best outturn worth there's rise within the average latency(double within the higher than figure). With additional increase within the arrival rates the increase within the latency gets larger.

Impact of Block Size

In this section all the experiments and therefore the observations inferred square measure created beneath the distributed design. Ordering part is wherever the transactions submitted square measure ordered into blocks with the defined blocksize and these square measure additional distributed to peers for validation part. not like the validation part wherever the validation of blocks happens in dealing wise, just in case of ordering part the scientific discipline scientific discipline happens in blocks. In earlier sections we have a tendency to study the behaviours of outturn and latency across different arrival rates. variable block size in conjunction with the arrival rates have AN effect on the outturn of the system and their behaviours square measure studied during this section. Figure show the behaviour of outturn and latency of the system beneath atmosphere four for insert transactions whereas variable the block-size and arrival rates.

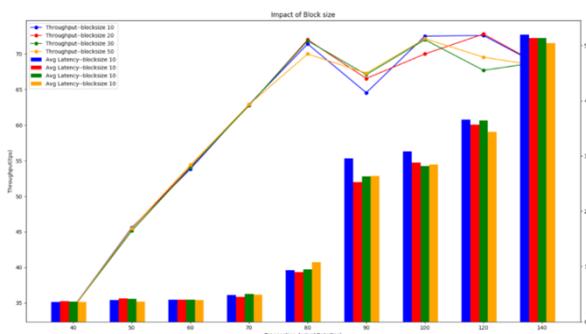


Fig 3 : Impact of blockchain on performance

Theoretically the effect of block size on outturn is explained throughout the ordering and validation phases of the dealing flow. With increase within the block size, the time taken to package the dealings into blocks increases at the ordering part increasing the waiting time of a transaction during this phase.

equally within the validation part wherever the validation of blocks happens in per-transaction wise, the rise within the block-size implies additional transactions packed in an exceedingly single block. it's discovered that the time taken in accessing the block is far higher because of the read-write latencies, so with higher block size the time taken throughout the validation part is lesser.

Usually within the context of land registrations in Asian nations, the arrival rate of transactions is assumed at 10-15 tps. additionally with a better block-size the waiting time of transactions in block creation throughout the ordering part will increase. therefore a lower block size (10) makes additional sense during this case. In this chapter, we have a tendency to evaluate the performance of our system beneath different operating atmospheres across numerous parameters. In section seven.2.1, we have a tendency to evaluated the system one by one for each insert and question transactions and in every case the analysis was done on different operating environments (Single-host vs Multi-host) and, arguments for the observations created square measure given. we finished that the system beneath distributed atmosphere performs higher compared to single-host atmosphere.

VI. CONCLUSION

The main purpose of this paper is to find whether or not group action blockchain technology to this business method of Land record management may be a viable answer or not? To answer this question a literature study is completed on the prevailing business method and through this study we tend to discover the issues related to the prevailing method. we tend to then create an associate argument concerning why we expect blockchain technology is the absolute best answer especially Hyperledger material. conjointly during this thesis, we've established the very fact that Hyperledger material may be accustomed to integrate blockchain technology into existing enterprise solutions. Although we've created an associate application to

mimic the prevailing method of land records, the most stress of the thesis is placed on the coming up with half and performance analysis of the blockchain network.

References

1. Satoshi Nakamoto. "A peer-to-peer electronic cash system", 2008.
2. Jake Frankenfield. Double Spending, 2018.
3. Artem Barger, Vita Bortnikov, Christian Cachin, Konstantinos Christidis, Elli Androulaki, David Enyeart, Christopher Ferris, Gennady Laventman, Yacov Manevich, Srinivasan Muralidharan, Chet Murthy, Binh Nguyen, Manish Sethi, Gari Singh, Keith Smith, Alessandro Sorniotti, Chrysoula Stathakopoulou, Marko Vukolić, Sharon Weed Cocco, Angelo De Caro and Jason Yellick. A distributed operating system for permissioned blockchains. Thirteenth EuroSys Conference, EuroSys'18, 2018.
4. The Zilliqa team. A Scalable and Secure Blockchain Platform, 2018.
5. A. Chiesa, C. Garman, I. Miers, E. B. Sasson, E. Tromer, M. Green and M. Virza. Zerocash: Decentralized anonymous payments from bitcoin. In 2014 IEEE Symposium on Security and Privacy, May 2014.
6. Rita Sinha. Moving towards clear land titles in India: Potential benefits, a road-map and remaining challenges, 2009.
7. N. Vishal Gupta P. Kiruba Rachel. Data Integrity – Regulations and Current Scenario, 2017.
8. Fred B. Schneider. Implementing fault-tolerant services using the state machine approach: A tutorial. ACM Comput. Surv., December 1990.
9. Fernando Pedone, Bernadette Charron-Bost and André Schiper, editors. Theory and Practice. Springer-Verlag, Berlin, Heidelberg, 2010. ISBN3-642-11293-5, 978-3-642-11293-5.
10. A. Bessani, J. Sousa, and M. Vukolic. A byzantine fault-tolerant ordering service for the hyperledger fabric blockchain platform. International Conference on Dependable Systems and Networks (DSN), June 2018.
11. Diego Ongaro and John Ousterhout. In search of an understandable consensus algorithm. In Proceedings of the 2014 USENIX Conference on USENIX Annual Technical Conference, USENIX ATC'14, pages 305–320, Berkeley, CA, USA, Bibliography 66 2014. USENIX Association. ISBN 978-1-931971-10-2.
12. Shubham S. Srivastava, Medha Atre, Shubham Sharma, Rahul Gupta, and Sandeep K. Shukla. Blockchains to detect insider attacks in DBMS. CoRR, abs/1901.00228, 2019.