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Generalised Design of Efficient Supply Chain Management System and Enterprise Resource Planning [ERP] System, Using Two Layer Blockchain Setup on Hyperledger Fabric and Ethereum

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ABSTRACT: Enterprise Resource Planning [ERP] and Supply chain management[SCM] systems are the most widely used software types in industry today. May it be manufacturing, IT or entertainment. This software is responsible for managing the data right from the basic stage of creation of a product to its handover to the customer. But this system has many flaws as the amount of data generated at every stage of both the supply chain and the stages of product creation in an organization, is very large. The transparency, contract management, validation and backtracking of a finished resource to its data in repository becomes a time consuming and tedious task. To solve these basic problems of ERP's and SCM software, we have come up with a design to implement the data flow model in such a way that generating, processing and storage of this data becomes more smooth, transparent and faster using Blockchain technology according to its application on Hyperledger Fabric.

KEYWORDS: Enterprise Resource Planning [ERP], Supply Chain Management[SCM], Blockchain, Hyperledger, Initial Coin Offering [ICO], Cryptocurrency, Mining.

I. INTRODUCTION

A] Blockchain is a decentralized ledger network which is transparent but encrypted in nature. As the name suggests, Blockchain is a chain of blocks which consist of a particular dataset. Thus such a chain results in automatic formation of a huge data repository as seen in figure 1. Each block and the data within it is encrypted thus making it secure. This block is accessible using a 256 bit Hash code. It is very difficult to crack as it is a combination[2] of uppercase and lowercase alphabets, ASCII symbols and numbers. Hence it makes a block very secure. Hash code for a new block is stored in the previous block. This connects all blocks with each other in form of a chain, simplifying the networking.

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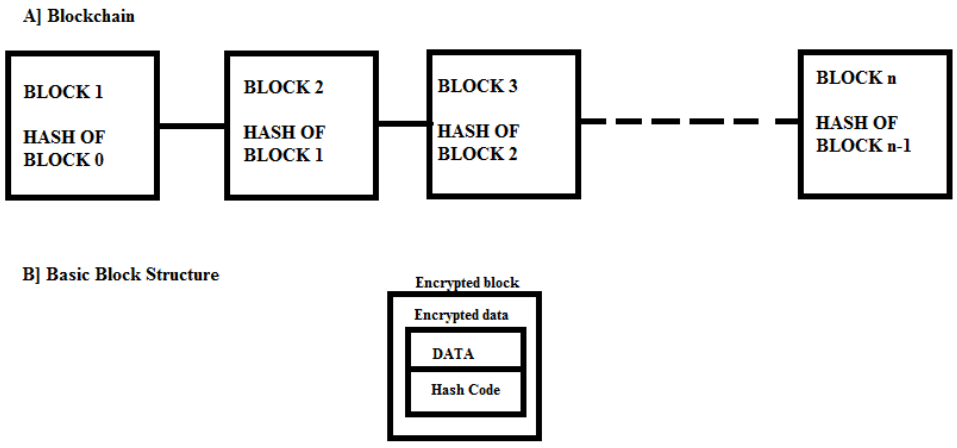

Figure 1

Blockchain does not have a third party centralisation such as in traditional networking models. Blockchain is decentralized in nature ie. There is no specific central server to control transactions. Each node attached to Blockchain has all the transaction records stored in it. This makes the probability of massive data theft very low as there is no central unit to steal the data from. We do not know that which transaction record is stored on which node. In a Blockchain, once a transaction is triggered, the nodes are notified for validating the contract. The fastest node to respond is given a bonus amount in form of initial coin offering[ICO]. This stamps the validation of underlying transaction. Once the transaction is complete, a block is created with the data under process, hash code and transaction records. This block is attached to the chain of similar transactions.

B] The ERP software which is being used in industry is basically a simple centralised way of updating, modifying, removing, marking and controlling dataflow. Such software is needed to be configured by the developers in the specific languages used by respective ERP software companies. Like SAP uses SAP ABAP language for all of its software configurations. The data is not visible to the developer which makes it difficult for developer to check if the configuration is as per requirement. The reason behind this data hiding is it's confidentiality. ERP's today are slowly adopting Blockchain technology in their methodology, but there is a huge limitation to the same. The ERP's were previously based on Oriental databases like SAP HANA and Oracle. These databases are huge in volume and are difficult to synchronize with the new Blockchain platforms like Ethereum and Hyperledger Fabric. As we see in fig 2, there are three layers of implementation of these existing ERP systems[1] bringing in the problems like Synchronization and additional delays, as the data being processsed has to go through two levels of validation, Blockchain contract and database security check.

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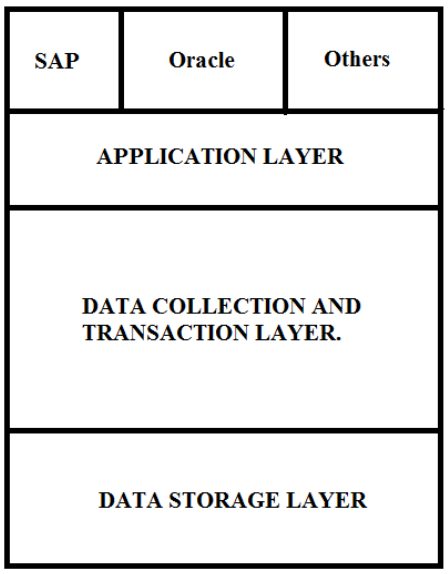

Figure 2

Blockchain mainly focuses on data abstraction instead of data hiding. This makes Blockchain more efficient than any centralised communication network like SAP or Oracle systems.

C] Hyperledger Fabric is a Blockchain implementation platform released by Linux in 2015 along with four other platforms. Hyperledger allows users to configure Blockchains using JAVA and Golang. Unlike Ethereum which has public transparency, Hyperledger allows users to configure the transaction and contract triggers in protected mode. Hyperledger has following layers as shown in fig 3.

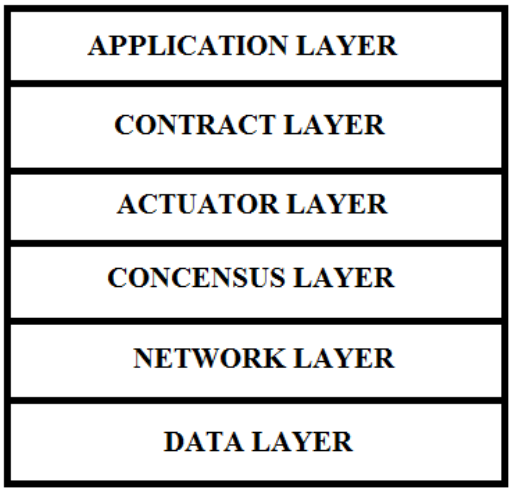

Figure 3

Hyperledger works on consensus layer for validating a transaction, which has three main components, namely Commiter, Endorser and Consenter. These three are responsible for validating, simulating and finalizing the transactions. There is no need of mining the hash code as in Ethereum, thus making this quick, safe and economic by making it miner bounty free, thus making it fit for industrial application.

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II. PROBLEMS AND PROPOSED SOLUTION DESIGNS

A. *Design Considerations:*

1. Hyperledger Fabric[4] Implementation: The suggested designs are based on Hyperledger fabric platform constraints. However with basic modifications, they can be implemented on Ethereum platform as well.
2. The design mainly focuses on the ERP and SCM implementations in upcoming new organizations. However it addresses and suggests the required modifications in old systems like SAP and Oracle as well.

B. *Description of the Proposed Algorithm:*

The design addresses four main problems faced in Centralized ERP's and SCM's. The further part will discuss the same and address to each issue individually from Decentralized Blockchain approach. In later section the individual solutions will be integrated to bring forth the complete workflow of the proposed module.

PROBLEM 1: Hash Data Generation And Organization

Industries like SAP are implementing Blockchain[SAP Leonardo] in the format as mentioned in section I.B. This basically leads to generation of random data in form of hash codes for every transaction of elements coming in and out of enterprise systems. Huge random data is created, making it difficult to index, organize[3], access and probe the data back to its source.

DESIGN 1: Design For Organized Hash Data Generation.

According to this design, as a supply chain triggers, a Hyperledger process triggers for each product. A specific hash code sequence will be assigned. This has code series will be fixed. Out of 256 bits, assume that [n] bits are fixed for maintaining the series, [256-n] are variable sequence. After each product completion, this [256-n] series will be shifted with a specific key, as seen in figure 4. This key shifting can be manual or automated. This revision of hash keys makes the generated data organized, transparent and faster. The generated blocks at each stage are assigned in a chain. This generates multiple Blockchains at each stage. There will be a final Blockchain which will be indexing all the Blockchains as seen in figure 4.

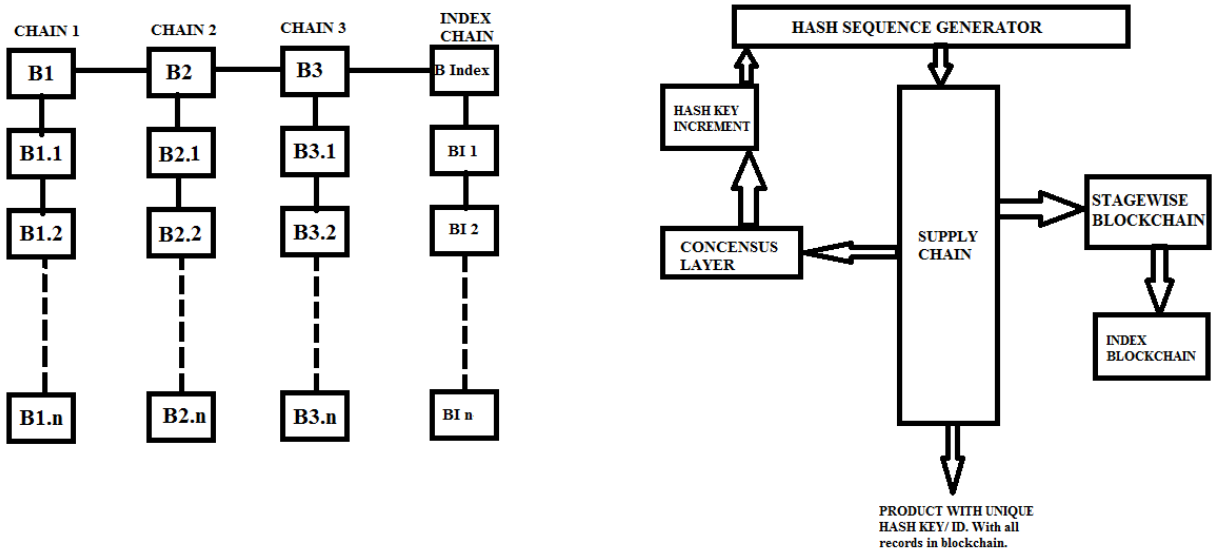

Figure 4

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This will help in tracking back any specific product to its specific stage of production. Ability of back tracking a produce will help in understanding the flaw point in case of any specific product related discrepancy.

PROBLEM 2: Mining Bounty Costs

As in traditional Blockchain implementation, after a contract comes into action each node in the network is notified of the transaction. The miners sitting on these nodes use a perfect hash code to validate the transaction. Once a miner validates the transaction, the miner is paid a small bounty in terms of ICO's aka cryptocurrencies. Once the bounty has been paid, the transaction record is stored in the nodes which were involved in transaction. This process repeats every time a transaction is being processed. This leads to a lot of tokens/ ICO's being used up on miners unnecessarily. Blockchains developed on Ethereum platform use miners for validation. This process of validation of a transaction is called Proof Of Work [POW] mechanism.

DESIGN 2: Bypassing Miners Or Circulating Home Grown ICO's

Many companies have started their work on Ethereum platform, as this platform is easier to integrate with the existing system as a patch layer over existing contract layer due to its transparency and open source nature. But as it has the miner layer involved in its architecture, using Ethereum platform is not suggestible for ERP and SCM implementation. Ethereum platform is public in nature thus making the data vulnerable to unauthorised access.

A good solution over this is growing in house ICO's. If an industry implements its own network on Ethereum, then it should implement it's own ICO's. This will help, as the tokens being mined by miners will always stay in circulation in that specific industry and nowhere else. The miners will be hired by the company and for the company specifically. The in-grown ICO's will have null value and will be used only as an element of completing the formality of validating a transaction. In this way the proof of work isn't bypassed in Ethereum and the mining costs are saved, making this model very economic.

Another solution over this can be using Hyperledger fabric instead of Ethereum. Hyperledger supports protected mode instead of public. This will help in keeping the data not fully hidden or visible either but abstracted from unwanted access parties. When it comes to validation of a transaction and proof of work mechanism, Hyperledger fabric uses a specific layer with three elements to do the same. It is called consensus layer.

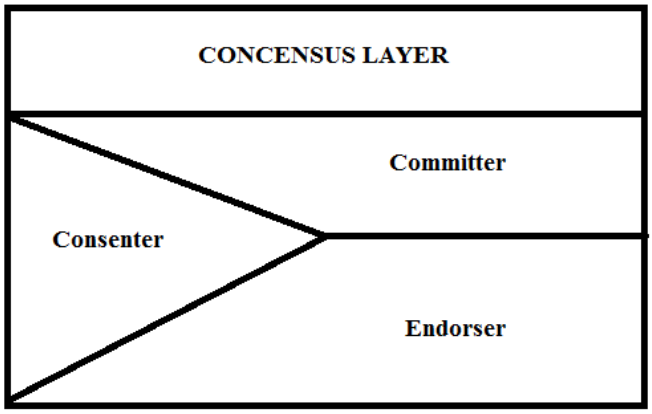

Figure 5

As seen in figure 5, This layer consists of three basic elements. Committer who validates the transaction, Endorser who stimulates and stabilizes the transaction and Consenter who finally authorizes the transaction. This Proof Of Work methodology does not require mining concepts and hence it is free of token exchange. This makes Hyperledger a perfect platform for industrial implementation of Blockchain for ERP and SCM.

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PROBLEM 3: Database Compatibility
Many leading and major organizations have already implemented ERP's like SAP, Oracle and Infor in their systems for integration purposes. The main concern in disengaging the three layer ERP model and integrating the organization on new and better Blockchain platform is difficult, time consuming and prone to loss of data.

DESIGN 3: Enterprise database compatibility design
D.3.1 Design for pre implemented databases.
As many of the industries have already implemented their ERP's and SCM's, their databases are pre designed. It will be difficult to migrate the data on Hyperledger fabric.So instead of that, we will insert a third layer of Ethereum based blockcain in between Application layer and database layer of a standard ERP as seen in figure 6. This will basically make all the transactions occur on middle layer and then the data will be stored in standard databases like HANA or oracle.

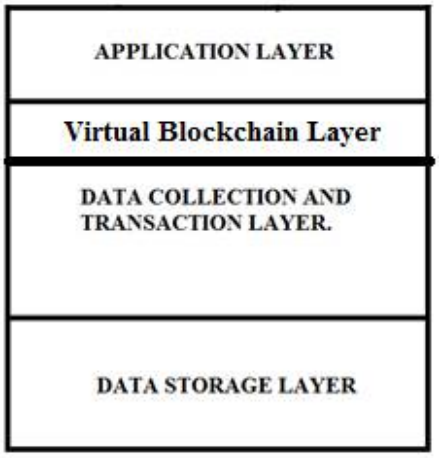

Figure 6

D.3.2 Design for new databases
As the databases for a new enterprise are yet to be created, they will be built on Hyperledger fabric from initaial stages of development of an ERP itself. Hyperledger fabric supports synchronization of its data storage functionality to database like PostgraSQL. It is an open source dynamic database which can be configured and used on Hyperledger fabric itself. This will cut out the formation of a virtual Blockchain layer between application layer and database layer as seen in figure 7.

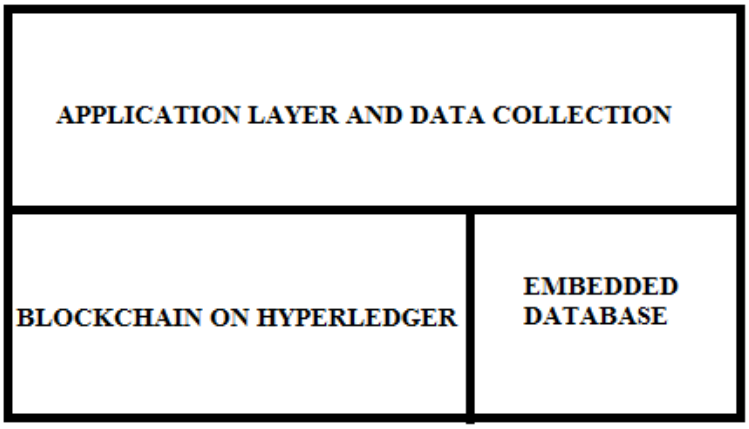

Figure 7

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As a result of this reduction in a layer in ERP architecture, the system will perform faster, as the hassle of integration will be reduced in newer systems being implemented on Hyperledger platform. The only drawback will be that upgrading oriental or traditional databases on Hyperledger will be a tedious task. Not impossible though.

PROBLEM 4: Integration Of Workflow With Blockchain In Picture
Designing the individual Blockchain implementation models is not that difficult as compared to designing its actual implementation in a supply chain. The main problem occurs when the data has to flow between the basic elements in a supply chain.

DESIGN 4: The Common Blockchain Supply Chain Procedure Injection
During communication between the departmental elements in a supply chain, there occur many transactions as a lot of data is transferred between two departments. This data has to be stored in a Blockchain format. There are five basic departments of any organization as shown in figure 8.

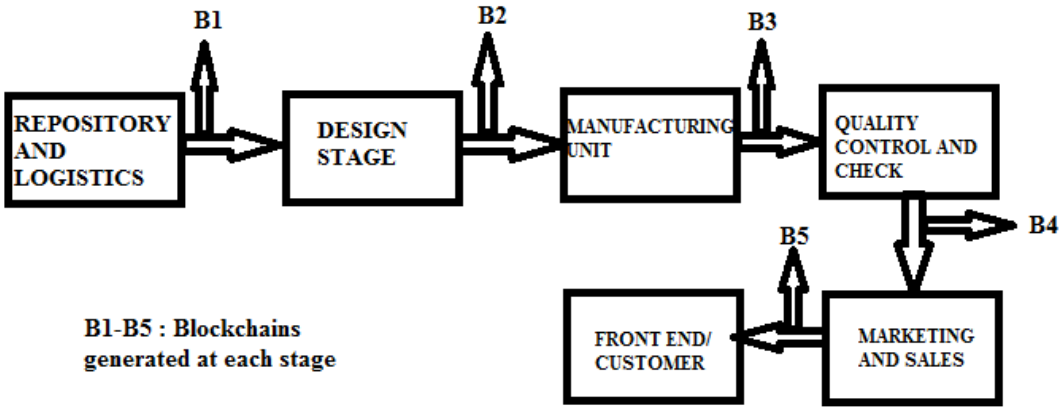

Figure 8

Assume the departments design and manufacturing are under a data exchange. This data exchange has to be recorded somewhere. The exchange will hence be triggered as a contract. The Proof Of Work mechanism will be followed and the transaction will be validated. Once a valid transaction is made, the data will be transferred and a block with the transaction record will be created. After each such transaction, a new block will be added to the Blockchain say B1 for the first data exchange between two primary stages of a basic supply chain. Such Blockchains with specific hash sequences will be formed between every stage of supply chain. This will directly help in maintaining a transparent database and easy organization of the same.

OVERALL DESIGN
In a supply chain, all the departments will be integrated with contracts and transactions between two departments under action. These transactions will form a Blockchain at every stage of the supply chain and enterprise resource flow. A Blockchain will exist which will index all the transactions, as shown in figure 9. As blocks in Blockchains are encrypted, the data security will be maintained along with transparency. The problem of public nature of Ethereum based Blockchain will be addressed as we are making the transactions by masking the sources with encrypted identities. Thus data will be unhidden but abstracted in nature, making it transparent and secure at the same time.

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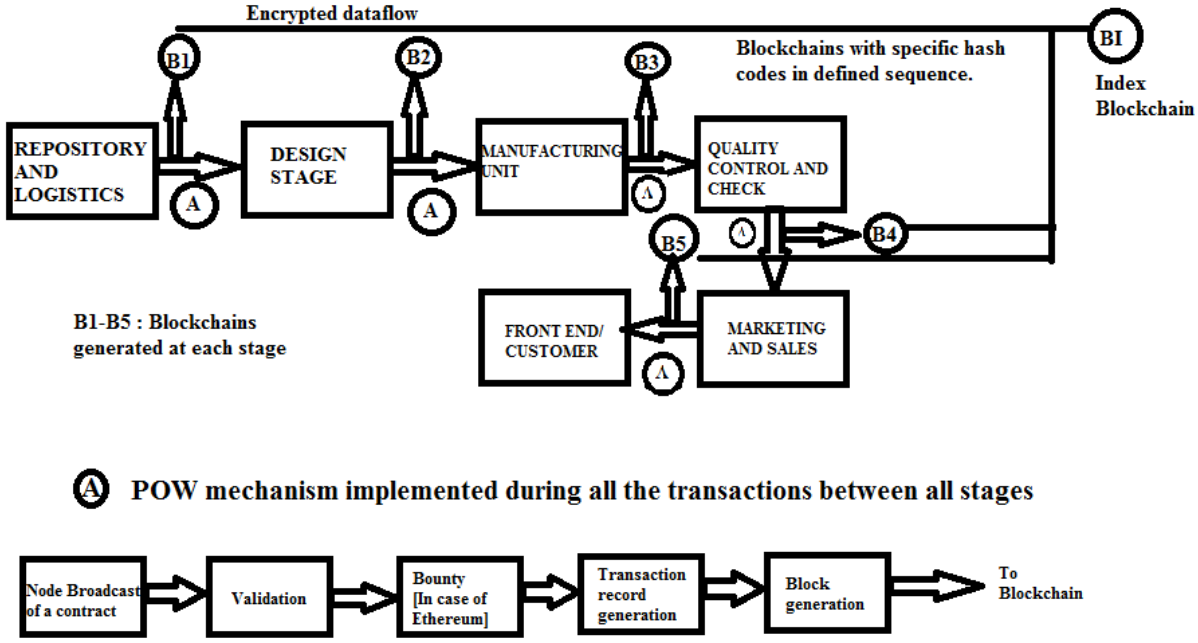

Figure 9

The Blockchains B1, B2 and so on will have hash codes assigned to them with specific series as discussed in section 2 Design 1. This will make back tracking and probing of data easier at every stage of the chain. These Blockchains consisting of data, transaction records and hash codes of next-in-line blocks will be stored over a database. These databases will be either integrated[D.3.1] or embedded[D.3.2] as per the requirement. The whole design will be implemented on Ethereum or Hyperledger Fabric. In case of Ethereum, the POW mechanism will use home grown ICO's thus reducing the bounty costs to miners for an organization implementing ERP and SCM over Blockchains. In this way the design can be implemented on any enterprise level for SCM and ERP.

III. UNIQUE FEATURES OF THE SUGGESTED DESIGN

1. This design makes every product unique with a specific hash key series assigned to it. An index of such series is created per timely manner in specific time slice as block. A head index of such indices is created. This technique of hash data organization is nowhere being used in Blockchain industry as of now as per our information.
2. Home grown ICO's for validation are used for intra-network Blockchain. This saves the bounty costs to be offered to miners. The coins circulate but stay in house, always.
3. According to this design, the need of forced integration is reduced as blocks tend to acquire/collect only the required data from source, rather than source initiating the data transfer.

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IV. ADVANTAGES OF THIS DESIGN

1. Security: The design provides an immense amount of security as the blocks in the Blockchain are encrypted, the data within a block is also encrypted and the hash codes are available t very specific people and blocks thus abstracting the data from unwanted audiences.
2. Speed and smoothness of dataflow: The Hyperledger fabric provides networking between the concerned parties hence bypassing the unwanted stages involved in a transaction. This improves the speed of contract validation and smoothness of overall transaction.
3. Transparency: Blockchain has a natural tendency to make required data available to anyone and anywhere, though conditionally.
4. Easy backtracking and probing: As the Blockchain of each individual stage is generated and a parent index chain holding records of all such Blockchains is generated, it becomes easy for flaw detection and probing on data level.
5. Removal of one layer in the architecture makes the working of the ERP and SCM more efficient, faster and transparent.

V. CONCLUSION AND FUTURE WORK

The proposed design is estimated to provide more transparency, smoothness, security and easy approach of organization of enterprise data using Blockchain technology. The simulation of this design is not yet possible as this is first of its kind and no known methodologies exist to implement and test the proposal. However, the design has a huge potential in future as gradually all the technologies are slowly adopting the Blockchain in their implementation due to its high end and potent properties. The design is expected to perform at a higher efficiency than the ERP and SCM software types present in market.

This design will improve user experience with a company, as the data of his concerned product could be made accessible to the customer on enterprise approvals. The transparency and security will make sure that the data does not go in wrong environment but at the same time is made available to the concerned party. The decentralized implementation will make data easily, quickly and safely available to concerned parties and will make sure that data is kept abstracted from unwanted nodes. This design is expected to bring a change in how ERP and SCM systems are implemented today.

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