Use of Blockchain in Vehicle Manufacturing Life Cycle Concept

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Abstract

"With the advent of Industry 4.0 , Blockchain is the new technology which current in its nascent stage but seems to have high prospectus in the coming decade. In todays senario when each application and tool is getting tied to the digital thread and each aspect of the data related to product is captured with sensors and exceptional devices thus making its place in Internet of things. This high diverse spectrum of data has changed the way will work in future. These technologies are bound to exponentially change the speed of growth. In such time we need to have strong foundation like Blockchain which will bring in more transparancy, trust , privacy , appropriate access sharing , and will channel the chaos inherant to these new technology coming in.

As rightly said by B. Bias, C. Bisiere, Executive Director American Blockchain Council : Blockchain in simple terms "Wherever people, processes, businesses, governments, or the social good requires proof of identity, ownership, transactions, or commitments; Blockchain technologies promise to meet those needs with a degree of trust and integrity never before possible" .

Keywords Blockchain, Lifecycle, Vehicle, Hyperledger

1. Introduction

The Blockchain is finding its strong place in the mainstream because of its unique properties tied in to the foundational making and it stands on the ground of shared network where relevant information can be seamlessly shared between different entities , which can be said to be immutable due to its timestamps tied to it , to bring in more transparency and tracking for any changes , these information transactions are said to be carved in stone , meaning any changes to that information will be updated to all the stakeholders / entities tied in to that blockchain network. These networks being access controlled, authorization driven which will grant freedom for complete transparency. Blockchain is devised such that it guarantees unhackable security against the unauthorized entity. With the advent of the new concept called Bitcoin, which was introduced in circa 2008, Blockchain was developed as a solution to bring the trust factor in dealing with cryptocurrencies, it was inducted into mainstream of peer-to-peer money transaction without getting bank, internet platform or any type of third-party interference,

1.1 Objectives

Blockchain is finding its strong palce in the mainstream because of its unique properties tied in to the foundational making and it stands on the ground of shared network where relavant information can be seamlessly shared between different entities , which can be said to be immutable due to its timestamps tied to it , to bring in more transperancy and tracking for any changes , these information transactions are said to be carved in stone , meaning any changes to that information will be updated to all the stakeholders / entities tied in to that blockchain network. These networks being access controlled , authorisition driven which will grant freedom for complete transparancy. Blockchain is devised such that it gurantees unhackable security against the unauthorised entity. With the advent of the new concept called Bitcoin which was introduced in circa 2008, Blockchain was developed as a solution to bring the trust factor in dealing with cryptocurrencies, it was inducted into mainstream of peer to peer money transaction without getting bank, internet platform or any type of third party interference.

In basic terminologies, Blockchain is a linear, continuous chain of blocks which are made up of digital piece of information, which consist of three parts - information about the transaction/workflow or any relevant information associated with respect to application it is implemented in. Second part consists of information of the participants, who are assigned unique digital signature (like a username). Lastly the third part is the identifier which distinguishes the blocks from each other, with the help of stored unique code called as hash.

While in broader understanding of block chain, K. Frenken and J. Schor defined with respect to Bitcoin is as stated - " Blockchain is a shared, decentralized, public distributed ledger on which transactions are digitally recorded and linked together so that they provide the entire history of an asset".

Blockchain is getting its place in new emerging fields of applications. The noted application of Blockchain apart from cryptocurrencies, banking and financial institutes,healthcare to secure the patient medical records, Land dealing and property use, additive manufacturing, and supply chain. It is as well recently tested in November 2018 midterm election voting in West Virginia. But in recent occurrence it is most effective application is in that of smart contracts.

Smart contract is the computer codes that are inbuilt in blockchain which works to facilitate, negotiate and finally verify the contract agreement between the parties upon completion of the conditions set by the parties. With the greater relief of the smart contract in place, the entrenched values associated with traditional contract between the parties are fulfilled with better accuracy, trust (due to predetermined rules and their encrypted records shared across participants, thus nullifying the question of any alteration), security (each block carrying the its own along with previous information code in form of "hash").

At large, the application is still in nascent stage of implementation on wider scope, the IBM Blockchain Platform help users to understand, learn and develop their own smart contract.

Thus, with scope of scrubbing up the mediators, third party red tapeism and time-cost worth ratios, Blockchain can be the stepping stone to actualize the better future .

There are handful of use cases in Manufacturing and Quality domain that many companies are trying to explore, in areas such as in APQP process where scope of blockchain will be useful in PPAP process, Some parts of Quality Inspections.

2. Literature Review

This paper focuses identifying the opportunities of utilizing blockchain technology in Manufacturing Sector system:

- Section 1: Potential use cases in Industry.
- Section 2: Advantages of utilizing blockchain in Manufacturing.
- Section 3: Implementation Overview
- Section 4: Challenges of blockchain.
- Section 5: Summary and Recommendations

3. Methods

In day-to-day manufacturing operations, we gather a lot of data while manufacturing a complete machine. The data is stored in multiple locations and databases. The irony is that even though we have all the data, gathering all this data in shortest possible time and effectively analyzing it for better solutions to solve an issue takes lot of effort, time & resources. Many times, we must rely on intermediaries to get some specific data. Sometime, specific accesses are needed to pull the data from different systems etc.

Scope of this paper is to seek the possibility to utilize blockchain technology building a system to ensure that each part on machine has information from its inception till the machine goes out of service. This system will work along with other technologies that will complement this purpose

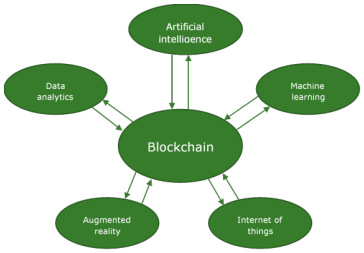

Figure 1: Block chain Methodology

4. Data Collection

Case 01: Vehicle Manufacturing Life Cycle:

From bird's eye point of view, we are envisioning picture of smart enterprise where blockchain is the backbone of system complimented by AI, ML, Big Data, AR & IOT. This paper explains one of the use cases refer "Figure 1".

Linking of all the part life cycle & machine life data using blockchain and, to utilize this data to strengthen the processes, enhance part & product knowledge.

Any part design will start with identification of similar parts or old part number. Warranty, NCCA & SAP Q-note information for similar or old part number will be available using IOT at this point of time where this data is analyzed for providing better inputs to design the part. This will ensure that the design will take the learnings from past experiences and field failures and it will eliminate/reduce most of the errors/issues which will happen in later stages of part development and during working life of that part. By using IOT and blockchain, this information will be available globally, at one place with just few clicks of the button and hence it will eliminate the communication gaps, between using entities and adopting entities as well as data restrictions between entities.

In next stage, when the part design is complete, it will move forward using workflow approach that is also listed on blockchain using auto completing contract method. As & when, all the associated tasks such as supplier EDA's, customer requirements etc. are completed & stakeholders digitally signs them, the block will get autocomplete & move to next step. The next step mentioned in above process are Design review, FGR & so on.

At this time, simultaneous processes will be triggered. Based on supplier non-conformance data, AE ratings, SQ data, part pricing data, an appropriate best fit supplier list for manufacturing/supplying that part will get populated. Bids will be initiated & based on AI logic of optimal bid (cost, quality & time), part will be offered to a selected supplier.

R. Gupta, S. Tanwar, discussed about in next step, the DPAR content will be auto generated using AI, ML & Data analysis & will be shared with required stakeholders After cross functional team discussions, contracts will get signed and PO will be processed directly. This will eliminate the intermediaries required for processing the tasks ahead manually. Supplier will start manufacturing the parts where the machines are linked to Blockchain that will document the part inspection data such as dimensions along with machine parameters, control plans & other manufacturing data necessary for PPAP approvals. This data will be then provided to AI using blockchain & AI will process the data and make

PPAP approval decision as Approved/conditionally approved or rejected. Hence, it will eliminate the need to manually verify the PPAP documents & send them back and forth for corrections. It will also help us to eliminate errors created due to judgements of individuals in processing this information, resulting in saving time and efforts

from quality engineering team and will also help us to eliminate the communication gap between supplier and factory.

After PPAP approval, when part will move into regular production phase, supplier will also be able to feed the Steel mill certificates, heat lot details and any such raw material data with the part number and will create a batch number for the parts. This batch number will have dates & quantities associated with them which will create its unique identity. These parts will come to factory in mapped batches & stored in FIFO order. When part will be consumed on assembly line, the associated batch number will get tagged to machine serial number with the quantities from the batch. It will allow us to link all parts batch information to machine serial number. This will ensure that all the parts on machine will have traceability throughout their life on machine.

On other front, in the factory shop floor, the different tools which we use for assembly of the machine are also tagged together to capture the data. This data will be mapped to a machine serial number using a block. All the SR Wrenches data, DC tool data & any such critical data will get linked to serial number. As the machine will progress through the line, fluid fill data, test data, calibration data, audit data & repair data will also get linked to machine. This data collection will use AI, ML, AR & IOT for capturing the most effective data that can give us insights in future. AR will help with audit as well as assembly, ML will help us capture the q-notes in standardized format so on & so forth. The data will also be utilized for getting the process health metrics as well as product health metrics.

moves out of factory to the dealer & gets ready to use in the field, it will start generating functional data that dealer/factory will be able to process for any potential failures, preventive maintenance, create flags for repairs accordingly before failure occurs in the field. The solutions or possible solutions will be available proactively which field service engineers can deploy on the machine and will result in reduction of vehicle downtime. The IOT application will also ensure to capture all such ongoing data with machine repair & preventive maintenance & will schedule the maintenance for future dates as well. This information will be recorded in a unique block and solutions. Overall, it will help us to reduce the problem resolution cycle time significantly.

5. Results and Discussion

5.1 Numerical Results

Hyperledger application can achieve a close to 900-1000 transactions per second. Hyperledger is the most relevant framework that can be applicable for manufacturing environment which is permissioned and has many advantages like:

1. A. Baliga, I. Subhod state that hyperledger application can achieve a close to 900-1000 transactions per sec It can run smart contracts in a very effective way
2. E. Androulaki mentioned that it has unique feature of getting consensus from all the participants / peers / stakeholders on the same network
3. Large volume of data is transferred every second which is immutable, reliable, traceable and every peer can trust the data as discussed by E. Androulaki
4. It has very general format and can be adopted by companies of any sector/ industry and can be synchronized for various types of applications

Because of all the reasons Hyper ledger fabric to run the smart contracts in the best to implement for the prototype application for the concept of Vehicle Manufacturing Lifecycle tracking. Refer fig 1

As the stakeholders of our vehicle manufacturing are geographically located and Hyperledger works for multi peer applications is an added advantage as we can connect in an access-controlled way with our vendors, logistic partners, Raw material providers. This can help when, for example when the planner has rent the forecast of the parts required at the specified timeline, it will be available on the Hyperledger fabric and viewable to all to respond

on the current inventory levels and the date the request was accepted. This data on the system being immutable cannot be changed or deleted being access controlled, this will enable to restrict the miscommunications and adherence of the timelines by all.

When participants in a blockchain network perform an action or update the status of their task/information on a blockchain ledger, all the ledgers simultaneously get updated without any delay. A new block is added, with whatever information is uploaded related to that vehicle orders and everyone can verify it. The components of the Hyperledger Fabric include peers such as order planners, vendors, logistic partners, production managers, quality managers in and other concerned persons in the production environment.

When any new information is added, the block is added to the ledger and its corresponding database is updated with real data of the transaction. Each person on the access permissioned ledger has their own Chain Code (Smart Contract) that is provided by the third-party network or (MSP)Membership Service Provider, this can be the factory specific IT team. R. Gupta, S. Tanwar mentioned a smart contract (chain code) is the application that runs in the form transaction over blockchain As in the production environment, we have more than one ordered for various organizations. Blockchain API is interacting with multiple interfaces to launch various transactions from the smart. For each launching transaction related to various organizations, we have multiple endorsements policies, such as transactions coming from planner, raw material vendor to logistics to various departments related to production.
Refer Figure 2 below

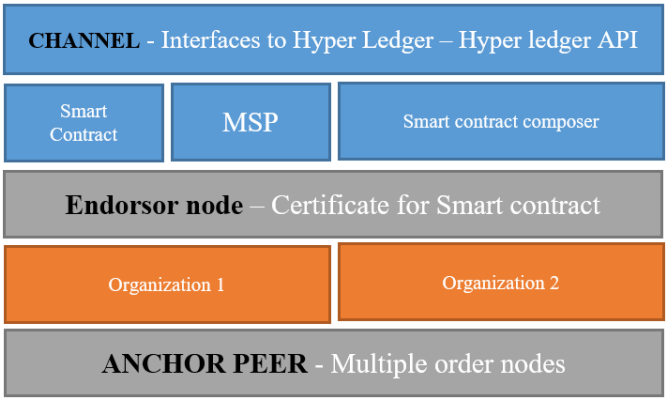

Figure 2: Components of Hyper ledger

So, the components of the Hyper ledger are:

Channel: It is an API / platform designed to execute the transactions that are smart contracts. This helps all the peers on the network to see it and connect to the Anchor (responsible to give access and makes available needed data for the peers to act) The Anchor can act as certificate authority for initiating the smart contract.

R. Gupta, S. Tanwar have stated about smart Contract: It's a certificate that is like agreement signed between the organization and the peer group which is set of unchangeable and agreed upon contract between two parties Thus the concept that is designed for the Block chain application is based on the Hyperledger and Smart contract application.

5.2 Graphical Results

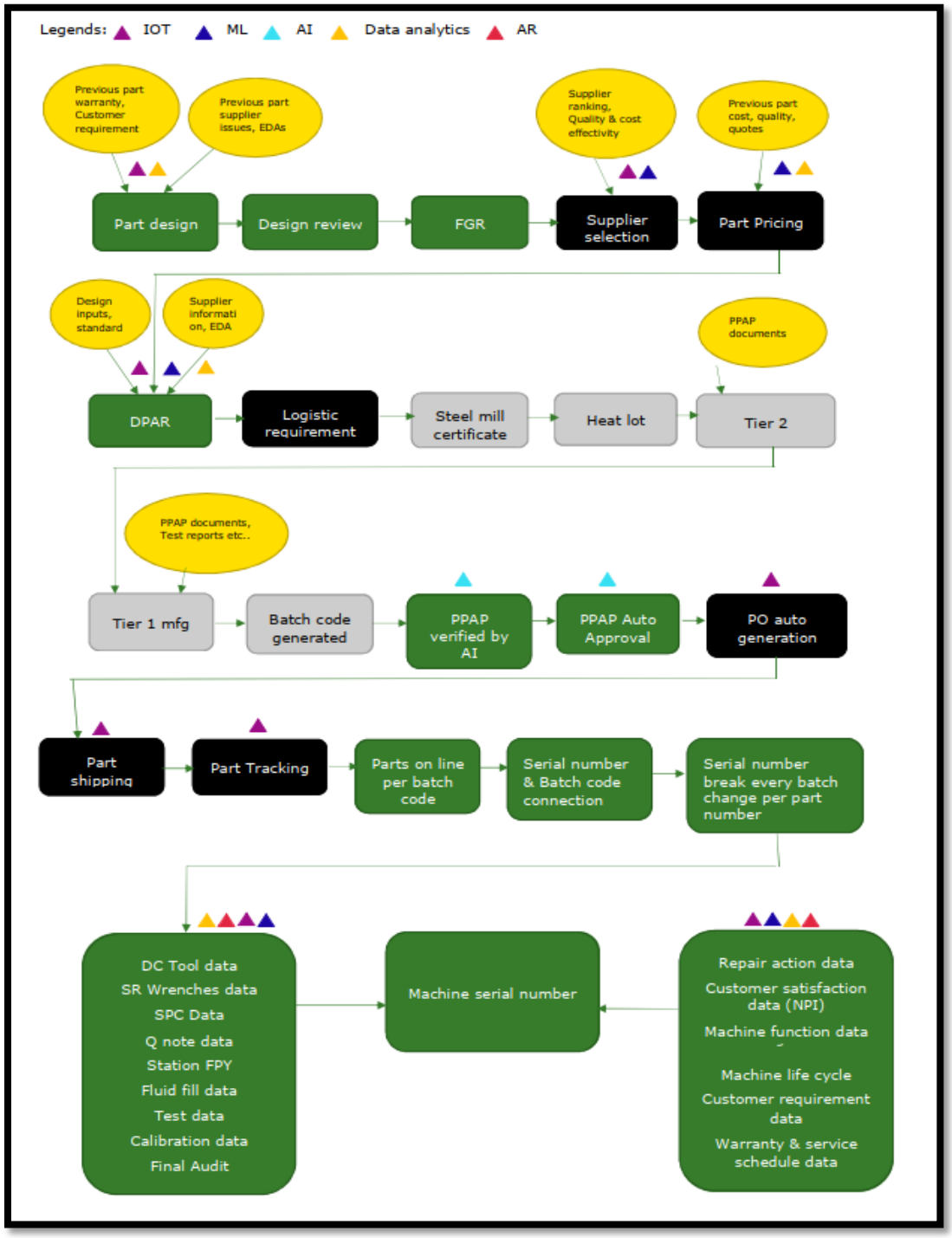

Table 1: Data Table of Graphical Results - Case 1 process

5.3 Proposed Improvements

Looking at above potential use cases, we feel that, if implemented correctly, the Blockchain technology will add tremendous value to the processes currently used in manufacturing ecosystem for product development. Through blockchain infrastructure, the data collection and its usage will be improved, and it will lead to elimination of intermediaries. As the data is shared with all the required stakeholders, it will help creating trust between suppliers, manufactures & customers along the way. This intern will help us to reduced overall project timelines. Even though

there are challenges such as unproven technology, cultural shift in the way we collect, process, analyze, share data but the system has lots of merits for us in long run. Hence, we feel that the pros of the Blockchain will outweigh cons listed above.

5.4 Challenges to Deploy Blockchain in Manufacturing Domain

1.Technology in Nascent stage: Blockchain technology is currently at its nascent stage. Till date, this technology has been utilized extensively in financial domain. K. Frenken and J. Schor have discussed even though IBM has tried to utilize this technology in aerospace industry for non-financial solutions but largely its use outside of financial domain is not yet in productionized phase. It can be a potential challenge to us when we can try to implement Blockchain in Manufacturing domain .

2. Initial Capital requirements: If we want to deploy the blockchain in Manufacturing industry as we have envisioned in “Case 01: Machine Life Cycle”, we may need to do initial investment in developing the architecture of the blockchain which will require integration architecture with IOT, Machine Learning, AI platforms with Manufacturing legacy systems. This investment will be higher in number. Additionally, we will need to develop new resource pool capable of developing such blockchain integration.

3. Scalability: As the blockchain technology has not been tested in manufacturing environment at large, we need to also explore more on its scalability for transactions for companies in manufacturing sector Since any global manufacturing company has multiple factories and eco systems, we need to test the wide scale adoptability of blockchain

4. E. Androulaki in his work states that currently blockchain has the capacity to create 07 transactions per second A detailed study needs to be conducted to evaluate its sufficiency level for Industrial setup/ system.

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5. W. Cong and Z. explained complexity of Block chain network for Manufacturing eco-system, since we are envisioning the interactions from supplier, customer along with internal stakeholders, we need to setup such blockchain infrastructure which is notoriously difficult to setup, scale and maintain which results in a challenge for most organizations.

6. Conclusion

This paper takes a bird’s eye view on the future Blockchain avenues or potential areas of implementation in the core manufacturing domain. As each sector is adopting industry 4.0 and, in its journey, can consider Blockchain as a foundational thread to be a more robust and efficient across global entities. This will be the journey to find pockets in the manufacturing areas to digitize to capture minute data and bring transparency upstream and downstream for right business decisions and actions. Blockchain though in its nascent stage has many obstacles and areas to be explored and scaled but this can be an envisioning point to start with in manufacturing domain.

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