

CASE STUDY : UTTARAKHAND STATE MEDICAL COLLEGE BLOCKCHAIN
BASED ASSET MANAGEMENT

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Case Study – Blockchain Based Asset Management Platform For Uttarakhand State,India

Delhi, India

Abstract

Health care is one industry where blockchain is expected to have significant impacts. Health care asset management faces limitations in leveraging advanced analytics and new sources of unstructured fragmented data (history, lab, socioeconomic, demographics, equipment data, patient data) as well as system interoperability and accessibility of medical records. The healthcare sector has large deployments of critical assets which must be available at the right place at the right time. This necessitates not only the locations of the assets being monitored in real time but also serviceability being ensured through predictive maintenance. The data can be aggregated and analyzed for meaningful inferences about the monitored process and assets. The asset information is critical both for privacy preservation and tamper proofing. Health care systems are overly complex and fragmented, and use multiple information technology systems, incorporating different standards for similar or same systems. To be meaningful, the health record of an individual needs to be from conception or birth. As one progresses through one's life, every record of every clinical encounter represents an event in one's life. Each of these records may be significant or insignificant depending on the current problems that the person suffers from. Thus, it becomes imperative that these records be arranged chronologically to provide a summary of the various clinical events in the lifetime of a person.

Blockchain in healthcare applications requires robust security and privacy mechanism for high level authentication, interoperability and medical records sharing. Blockchain does offer a promising new distributed framework to amplify and support integration of healthcare information across a range of stakeholders and enable real time asset management. The technology addresses several existing pain points and enables a system that is more efficient, disintermediated and secure. In this paper, we shall deep dive into the case study of Blockchain Based Asset Management System which is integrated with a Hospital Management System. This Proof of Concept has been successfully delivered at the Department of Medical Education, Haldwani College, Uttarakhand.

Keywords.

Blockchain technology, Healthcare, Electronic Health record, Distributed Ledger Technology, Decentralized Technologies

Introduction

Blockchain Technology

At its core, Blockchain is a distributed system for recording and storing transaction records. More specifically blockchain is a shared, immutable record of peer-to-peer transactions built from interlinked blocks which are secured using cryptography . Each block contains a cryptographic hash of a previous block, timestamp and transaction data. Blockchain relies on established cryptographic techniques to allow each participant in a network to interact (store, exchange, or view information)without preexisting trust between the parties. In a blockchain system there is no central authority ; instead, transactions records are stored and distributed across all network participants . Interactions with the blockchain become known to all participants and require verification by the network before information is added , enabling trustless collaboration between network participants while recording an immutable trail of all interactions.

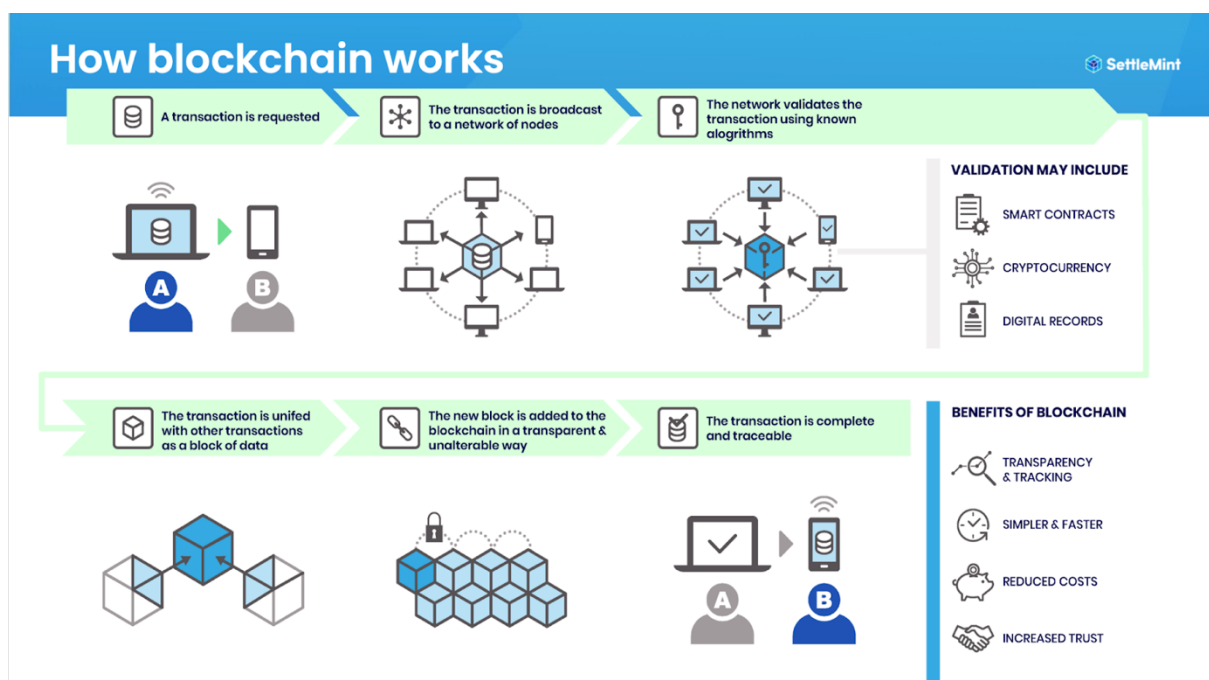


Figure 1 : How Blockchain Works

Blockchain technology makes true business sense when the following conditions are met :

- Multiple parties generate transactions that change information in a shared repository
- Enable distributed autonomous marketplaces
- Reduce frictions in business transactions and reconciliations
- Enhanced security is needed to ensure integrity of the system
- Track the provenance of products and materials.

Benefits of Using Blockchain Technology

Using the blockchain to store medical records has the potential to make private healthcare data more tamper- proof, secure, and auditable. The distributed nature of the blockchain can ease the sharing of data among authorized parties and bridge traditional data silos, dramatically increasing efficiencies and improving the coordination of care. Costs of medical care can be decreased through better asset management and coordination with multi departments. Data auditing is improved through the immutable records maintained by the blockchain.

Current State Overview

The Department of Medical Education, Uttarakhand has established medical, Dental, Nursing and Paramedical colleges for providing comprehensive medical education. A medical college is an institution which provides medical education and medical treatment facilities. Eg GMC Halwdwani there are 7 medical colleges. One medical college can contain multiple hospitals and there are several departments in each medical college as per their nature of work . eg pathology, radiology , biochemistry , general medicine. The issuance and consumption of assets in the medical facilities in various colleges is currently manual driven through paper ledgers/registers. There are two types of assets which are used by various departments of medical colleges - fixed assets and consumable assets . When any department observes in their ledgers /registers that any item(s) are going to be exhausted , they issue an indent to purchase the items . The indent goes to the approving authority (HOD/Principal) for approval. After approval the indent reaches the purchase section selects the vendor and generates the Purchase Order. Vendor supplies the material to the central store as per the issued purchase order. Requesting department is updated about the delivered item and its HOD generates a requisition request for receiving the item from Central Store. Central Stores finally issues the item to the requesting department against the requisition request.

The current process has the following limitations : -

- Manual Intervention of record keeping prone to human error and fraud
- Improper record of assets issuance, utilization and consumption
- Absence of interaction to other medical colleges in the state for a unified asset allocation system.

The Pilot/Production Roll out aims to digitize the process and mitigate the inefficiencies in the process while bringing transparency in asset issuance/consumption across colleges. The movement of assets as well as the approval of the movement will be recorded on the blockchain. The process will also automate Item indentation, Item Purchase Flow and Item Condemnation flow.

The blockchain based application integrated with the HIMS system will enable the patient to have control of his data through a mobile app . The HIMS software will register each patient with the help of a unique QR Code (ID). This ID will contain personnel and demographic data. During subsequent visits patients medical records will be automatically fetched using the application.

Proof Of Concept : Haldwani State Medical College

The Proof of Concept for Blockchain Based Asset management system is currently being deployed at Shri Sushila Tiwari Hospital, Haldwani . The medical college monitors the movement of fixed and consumable assets through central stores and sub stores .

Central Stores- These are stores in medical colleges who receive and store all items used in the medical colleges(consumable or assets). These items are dispatched to departments (through departmental substores) on request basis. Any inflow of any item in the medical college is done via Central Stores. All item details are kept by Central Stores in their respective Central ledgers.

Central Store Pharmacy - This store keeps the medicines items in its inventory. E.g., tablets, capsules, injections, masks etc.

Pharmacy Substore- This store keeps daily used pharmaceutical items which it procures from Central Store pharmacy. It dispatches these medicines to wards on request basis.

Central Store General Items - This store keeps items other than medicines. These include general items (e.g., stationery, sanitation, repair, maintenance), Chemicals/Kits used in Laboratories (glucose test reagent tape), Assets/ Equipment's (e.g., ECG machine, x-ray machine)

Substore - Substore is a store in any department, ward or office which stores and manages items for its department. Substore requests the items from Central Store (Pharmacy or General) via a requisition slip. Each substores have their respective Central ledgers where they keep the updated inventory. A Substore can also request items from another Substore.

Item Inflows - Only Central Stores have the right to add items into the medical college inventory. All the items are transferred from central stores to any substore and further substores.

Polygon Edge - a modular and extensible framework for building private or public Ethereum-compatible blockchain networks. The Polygon protocol is designed to operate in a trustless environment, where no assumptions are made about the safety of the incoming transactions and block relay messages. Each node independently validates every transaction by executing the smart contract. All nodes are expected to have exactly the same copy of the "ledger", or the long list of transactions packed into chains of blocks. Rogue behavior can be easily detected by mismatched hashes from the different states that do not fit in the merkle tree.

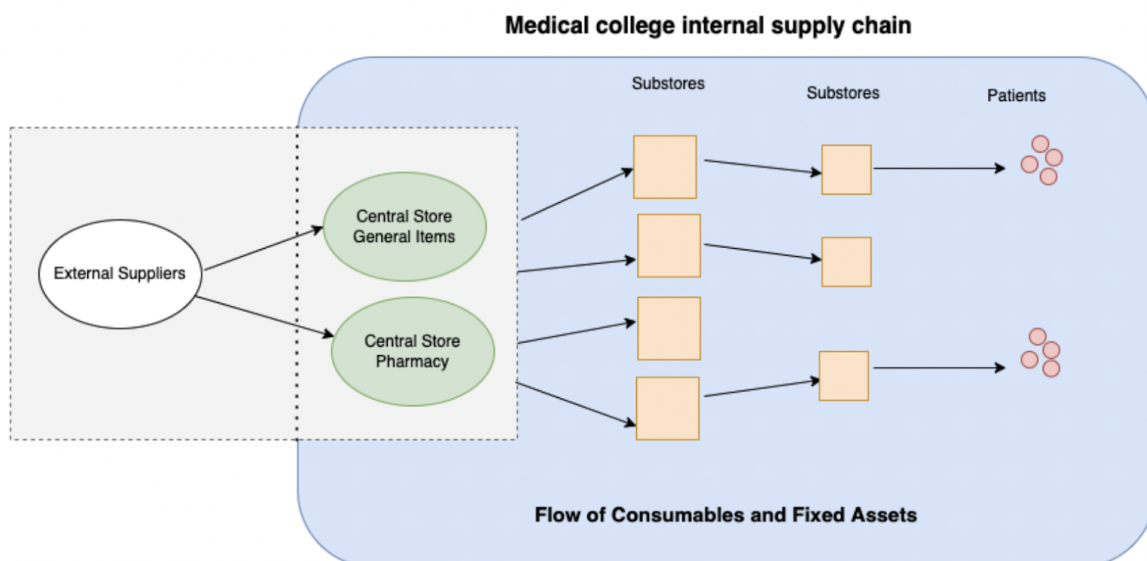


Figure 1 : Medical College Internal Supply Chain

The pilot has been deployed with the following objectives in mind: -

- Transfer of fixed assets, inventory and Tracking
- Transfer of Consumable assets and inventory
- Reporting of Asset movement through analytics

The application architecture is as below :-

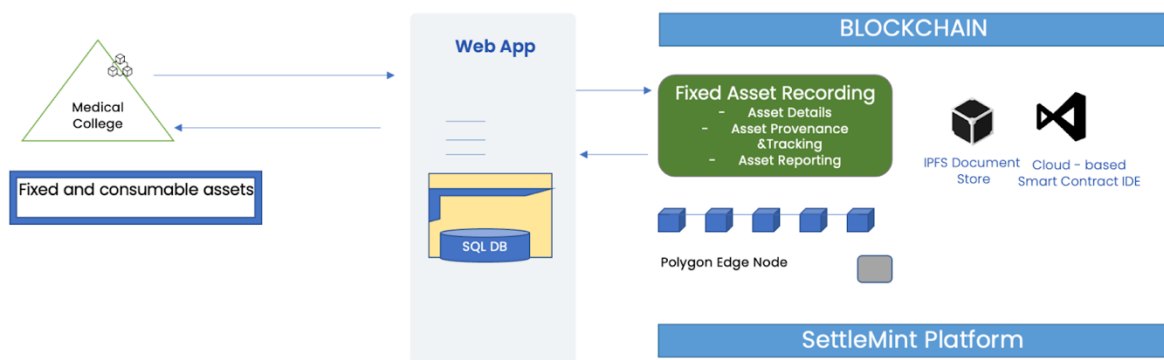


Figure 2 : Application Architecture ; POC Haldwani medical College

The project has been live since June 2022, Currently as of August 2022, 47433 transactions have been logged on the platform with 172 active users, 112 active vendors , 19 categories of assets, incorporating tracking of 1182 consumable assets and 894 Fixed assets.



Figure 3 : Dashboard – POC Haldwani Medical College Permissioned Blockchain Based Asset Management System

Production Roll out

After successfully iterating through proof of concept in Haldwani Medical college, the Department of Medical education wishes to roll out the application for all medical colleges in the State. The objective of the project will be to provide a blockchain enabled platform for Uttarakhand State medical colleges' tracking consumption and issuance of fixed and consumable assets. The project shall effectively result in 7 integrated applications with blockchain enabled asset tracking systems. The larger goal of the application is to enable ownership of data to the end users – patients through an integrated third party HIMS application.

Scope of The Project

Objectives

As explained earlier , the current process for asset issuance and movement is manual and managed in paper ledgers/registers by medical colleges. The objective is to enable digital transformation of the existing process of medical colleges along with an interoperability between different medical colleges. The blockchain based platform will unify the asset/consumable issuance and consumption and also enable inter - college transfer . The unified inventory will help in reducing wastage and optimize unity of assets through preventive care of high value medical assets .

Following are the desired outcomes of the project : -

- Currently Fixed and Consumable Asset management is a manual process using physical registers and ledgers. The application will digitize these process among the medical hospitals
- The proof of movement of assets and identity of approvers and administrators who approved that movement will be immutably stored on blockchain for audit and provenance purpose
- Once assets are onboarded and recorded over blockchain, it shall also enable transfer of any asset among medical colleges in future
- Visibility into asset consumption and usage on department and medical college level shall allow tracing any asset as well as reducing asset wastage in the long term
- Reduce manual processes to result in cost saving in the long term

The application will also be integrated with a HIMS and will enable the patient to have control of his data through a mobile app . The HIMS software will register each patient with the help of a unique QR Code (ID). This ID will contain personnel and demographic data . During subsequent visits patients medical records will be automatically fetched using the application.

Asset Categorization

For simplicity, the assets can be categorized into 2 parts: -

Fixed assets & equipment - These are the non-consumable items which are transferred to a substore on an individual basis on less frequency. They are generally used for long term by a substore. This involved machinery, equipment, IT hardware etc. Examples of fixed assets could be X-ray machines, MRI machines, stethoscopes, computer hardware etc. Important requirement for these kinds of assets is to track and locate them on an individual basis, as well as to track their availability and non-availability. For e.g., an admin would like to know where a certain ECG machine is right now, and when it has been unavailable or non-operational in the past year/month.

Consumable assets - These are the types of items which are frequently consumed by hospital staff and patients. They are procured by substores from Central stores on a frequent basis. Examples of consumable assets could be medicine, injections, lab reagents, daily stationery.

Software would see the fixed assets as something which one store can transfer to another individually (or can mark condemn). Whereas for consumable items, one store can transfer multiple units to another store, mark consumed (or adjust) a certain number of units multiple times against its availability.

The assets would further be classified into categories and sub- categories. For example:
Item - Injection Amox 5mg, Type-Consumable Assets, Category- Injections, Specification - NA

Process Flow

The Substore incharge generates a requisition for receiving items from the Central Store or any other Substore. The requisition has to be first approved by HOD of the substore. The requisition then reaches the Central Store. The Central Store issues the items against the requisition, and updates its central ledger. The Central Store keeps the requisition slip and provides the issue copy to the substore. The substore receives the items and updates its central ledger.

This flow starts when items already procured in Central Stores are required by any substore. This is the same flow when a substore makes requisition for items from any other substore. This will include the item indent and purchase flow which is to be dealt separately.

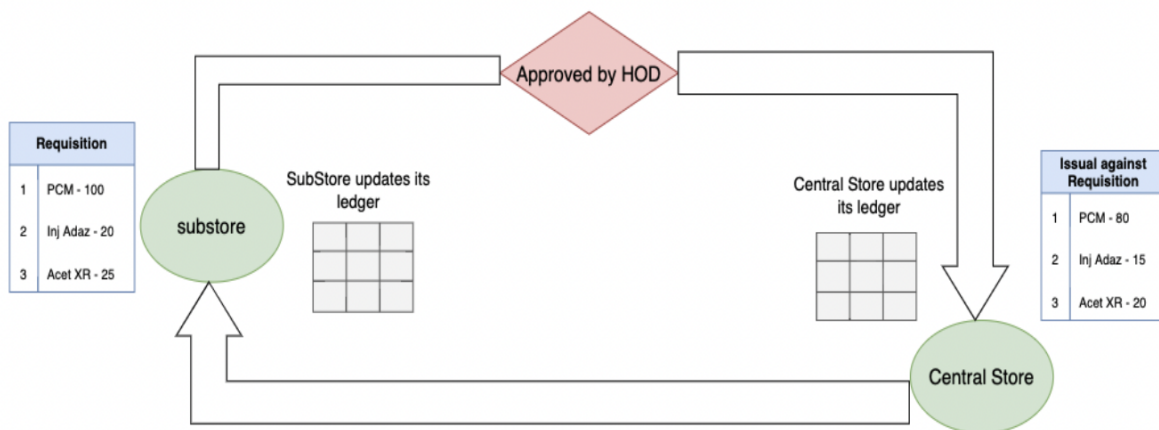


Figure 4 : Process Flow

Only central stores can add an item to their inventory list as they receive items from vendors. They can go to their dashboard and search any item and add them to their inventory. Central Stores can check their inventory and also set reorder levels for any item after which they will get a warning regarding the availability of the item.

Central Store can issue consumable items to any substore. After issuance, the inventory of both central and substores will be updated as per the issuance quantity.

The application will correspond to following functions : -

1. Sub Store consumption for consumable items
2. Transfer of Fixed Items
3. Item Condemnation Flow
4. Item purchase Flow
5. Inter medical college issuance
6. Analytics of utilization of assets
7. Trigger for preventive care schedule of critical medical assets.

Application Architecture & Components of Application

The web application for medical college shall be provided to all 7 medical colleges to manage their fixed and consumable assets. Each department admin thereafter shall be able to manage assets as per their role assignment using the web app. The medical colleges can transfer and trace assets/information among each other. There shall be provision to transfer the fixed assets on the blockchain among the medical colleges. There shall be provision for a high level reporting on all medical colleges level as per the requirements. The fixed assets shall be recorded on the blockchain along with their location and other details providing traceability between departments.

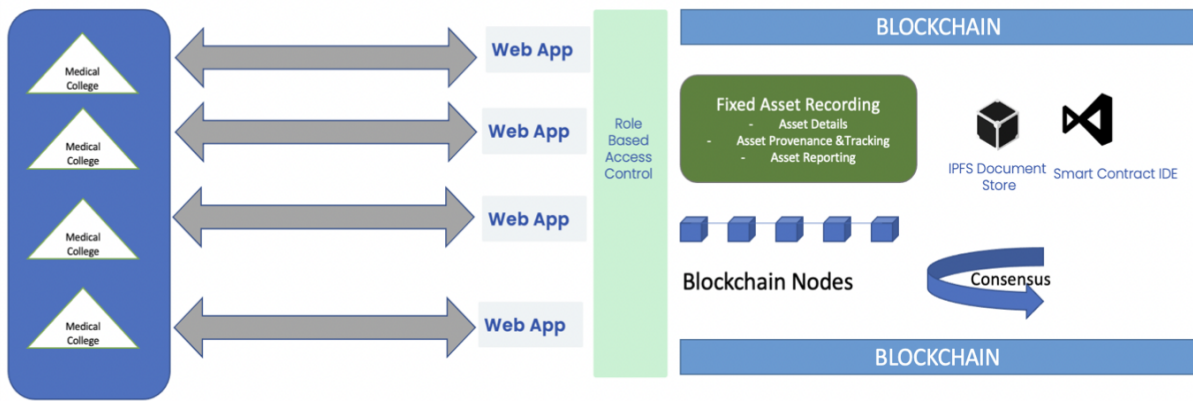


Figure 5: High level Architecture for the Blockchain Based Application

The blockchain based asset tracing will track fixed asset and consumable assets with each substore within or among medical colleges. We shall be tracking the proof of transfer of all types of assets on blockchain including both fixed and consumable

The solution will be facilitated by a Blockchain platform. During each stage of asset transfer, the data shall be recorded on Smart Contract applications deployed on the blockchain network. Application shall have the capability to query that data effectively by the frontend application.

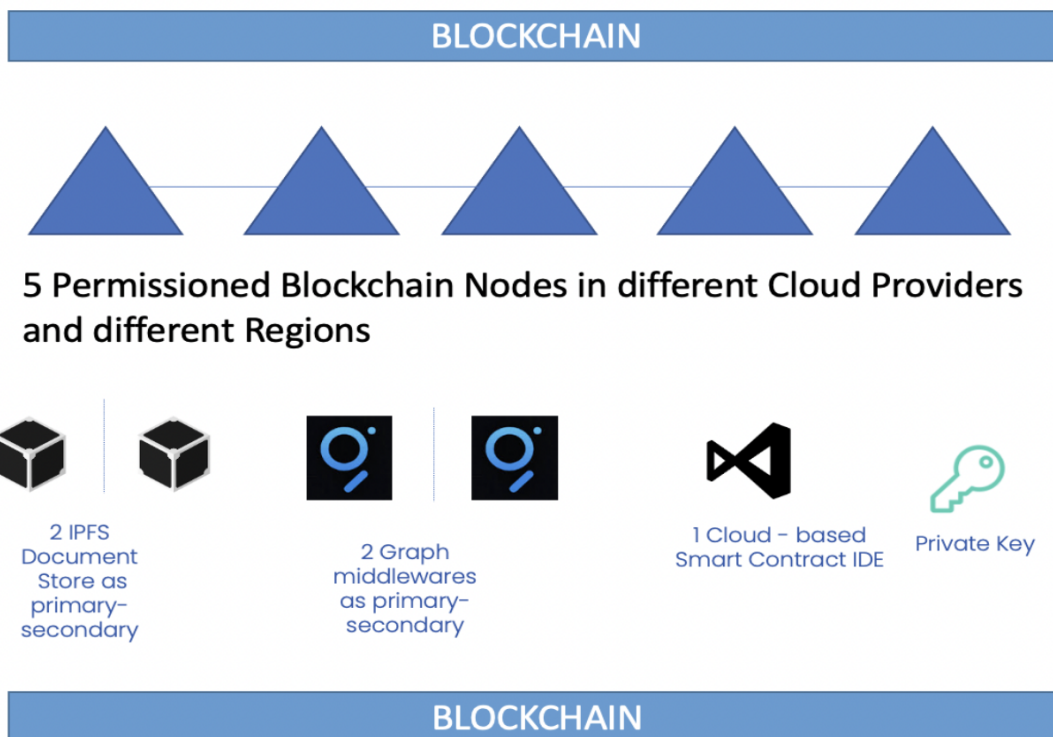


Figure 6: High level Architecture for the Blockchain Based Application(Production Roll Out)

Blockchain Service Layer - This is an abstraction which shall deploy blockchain networks and associated components and tools.

Network - The deployed network shall consist of few permissioned blockchain Nodes which shall act as a validator node. The nodes shall be deployed on public clouds in different regions to be Fault tolerant and highly available.

Smart Contracts - The smart contracts contain business logic for the application. They shall be deployed on the Blockchain Node. Front end applications shall be able to interact with the smart contract (if they have the authorization). Smart Contracts shall be deployed on the Node using a private key which shall act as Uttarakhand Hospital App's private key.

IPFS - Interplanetary File System shall be used for storing data. Data for each stage in the manufacturing process shall be recorded over to the IPFS. The CID (address) of the file generated in the IPFS shall be stored in the smart contract program.

Graph Middleware - Graph Middleware shall use the Graph Protocol to listen to smart contract events to produce and store query(able) data.

Conclusion

Healthcare is at a crisis globally with global demand for medical services outpacing the ability to pay for it. These two factors, an aging population with fewer working age people to pay for their medical costs, along with steadily increasing costs of medical care, are creating an enormous pressure on governments and businesses to find innovative ways to make the delivery of health care more efficient and less costly. Advances in technology to tame the bureaucratic burden of medical care will provide a primary means to accomplish these goals. Enterprises/Governments are gravitating towards online forms of data storage and transfer with a secure form of interaction between them. This is the reason why Blockchain technology is a good fit for capturing critical data information across multi departments. Blockchain technology is a peer-to-peer decentralized trustless network with a ledger and automated access control manager where members can interact without any trusted intermediaries and any form of malicious activities. Blockchain technology uses heavy cryptography which gives the interactions between each node of the network a sense of authoritativeness. Smart contracts are self executing programs on the blockchain which enables distributed and autonomous workflows.

Health and medicine management data is integral and critical to the government for maintenance and preventive care of assets as well as enabling transparency through HIMS integration to the patient medical records. The asset management system was designed using blockchain technology and smart contracts to maintain transactional data integrity and

security as well interoperability between multi participants like medical colleges. The Proof of Concept is successfully deployed and implemented, and it is capable of resolving data security and integrity issues with an existing framework by utilizing Blockchain Technology and the Smart Contracts feature. The transactional data is safely transmitted across the network.

Blockchain technology has the potential to be used in a variety of other applications such as healthcare ,banking, supply chain, logistics, telemedicine etc.

Uttarakhand State is one of the early adopters in India to recognize the vast potential of blockchain technology and become an early adapter in creating blockchain based governmental systems.

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