

Blockchain Applications in health care for COVID-19 Vaccine Tracking

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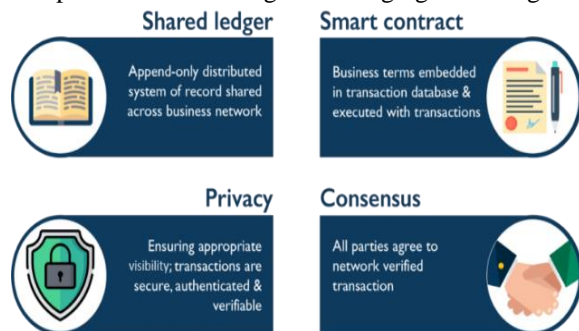
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Abstract-Blockchain is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network. An asset can be tangible (a house, car, cash, land) or intangible (intellectual property, patents, copyrights, branding). Virtually anything of value can be tracked and traded on a blockchain network, reducing risk and cutting costs for all involved. Blockchains are distributed systems that log transaction records on linked blocks and store them on an encrypted digital ledger. In other words, a block is a record of new transaction (medical data like medical device logs, patient's sensitive information, temperature-sensitive medicine info during transport TTSP time, or the location of cryptocurrency). When a new block is completed it gets attached with the old previous blocks carrying information and this way blockchain is created.

INTRODUCTION

What is Hyperledger Foundation?

Hyperledger Foundation is an open source community focused on developing a suite of stable frameworks, tools and libraries for enterprise-grade blockchain deployments. It is a global collaboration, hosted by The Linux Foundation, and includes leaders in finance, banking, Internet of Things, supply chains, manufacturing and Technology. Built under technical governance and open collaboration, individual developers, service and solution providers, government associations, corporate members and end users are all invited to participate in the development and promotion of these game-changing technologies.



WHAT IS HYPERLEDGER FABRIC?

The fabric was intended for developing solutions with a modular architecture. Hyperledger allows the components to be plug-n-play.

It is a private and permissioned Blockchain system which means Unlike, in Permissionless (or public network) systems that allow unknown identities to participate in the network, the members enrol through Membership Service Provider (MSP).

It also offers the ability to create channels, allowing a group of participants to create a separate ledger of transactions.

Since Fabric is the permissioned Blockchain it has some major advantages over other blockchain systems.

Key Benefits of Hyperledger Fabric



Hyperledger Fabric Model

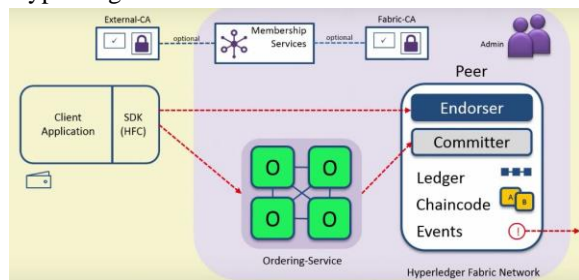
Following are the key features of Hyperledger Fabric that fulfill its promise of customizable enterprise Blockchain

- **Assets:** Enable the exchange of monetary value over the network
- **Chaincode:** Partitioned from transaction ordering, limiting the required levels of trust and verification across node types, and optimizing network scalability and performance
- **Ledger Features:** Encodes the entire transaction history for each channel, and includes SQL-like query capability Privacy through

- Channels: Enable multi-lateral transactions with the high degrees of privacy and confidentiality
- Security & Membership Services: In Permissioned membership participants know that all transactions can be detected and traced by authorized regulators and auditors
- Consensus: Allow network starters to choose a consensus mechanism that best represents the relationships that exist between participants

HYPERLEDGER FABRIC – TRANSACTION FLOW IN BLOCK CHAIN

Hyperledger Fabric Architecture



Membership Services is going to be providing the notion of identity for the users who are going to be transacting on the block chain. So, this identity is going to be a digital certificate and users are going to be using this digital certificate to signed that transaction and submit them to the block chain and the benefit of signing this transaction is 2 fold one they authenticate with the block chain that they are a legitimate user and 2 it also ensures that they get the right access privileges on the block chain for the transaction they are performing .

Like mentioned we do have notions of access control, so certain users are allowed to perform certain transactions and if you do not have the right access then your transaction will get rejected. So your certificate is going to have all that information about you what privileges you can have what attributes you have and we use that to transact on the block chain. Now how do the certificate where do the certificate come from you, it comes from traditional certificate party right.

Fabric implements a certificate authority so this is the fabric CA and this certificate authority is optional. So, it only all does is issued the certificate, so you go to the certificate authority and say ok I am XYZ I would give me a certificate and it will then issue this certificate saying this public key belongs to XYZ ,

XYZ has these following attributes and so on .So, that is the role of the certificate authority.

Nodes and Roles

Committing Peer : Maintains ledger and state. Commits transactions. May hold smart contract (chaincode).

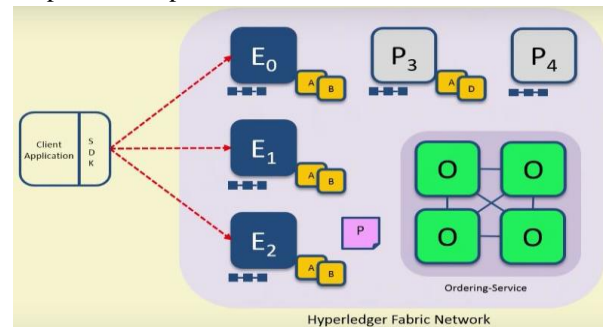
Endorsing Peer : Specialized committing peer that receives a transaction proposal for endorsement, responds granting or denying endorsement. Must hold smart contract.

Ordering Node : Approves the inclusion of transaction blocks into the ledger and communicates with committing and endorsing peer nodes. Does not hold smart contract. Does not hold ledger.

Transaction Flow

Consensus is achieved using the following transaction flow :

Steps 1/7 : Propose Transaction



Application proposes transaction

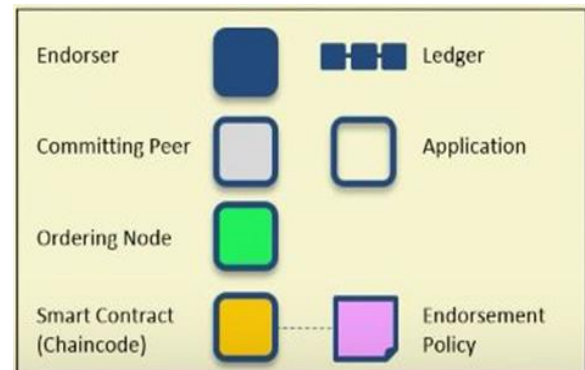
Endorsement policy :

"E0, E1 and E2 must sign"

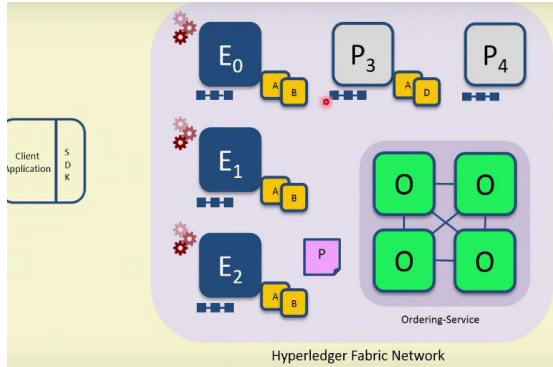
(P3, P4 are not part of the policy)

Client application submits a transaction proposal for Smart Contract A. It must target the required peers {E0, E1, E2}

Key:



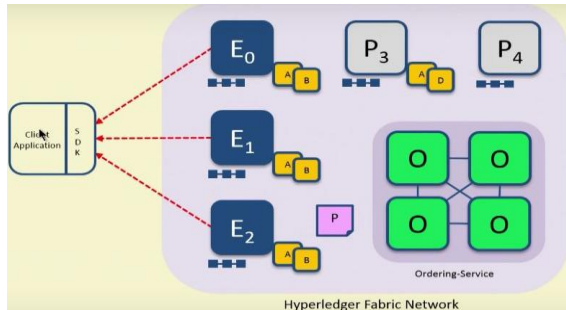
Step 2/7 : Execute Proposed Transaction



Endorsers Execute Proposals

E0, E1 & E2 will each execute the proposed transaction. None of these executions will update the ledger. Each execution will capture the set of Read and Written data, called RW sets, which will now flow in the fabric. Transactions can be signed & encrypted.

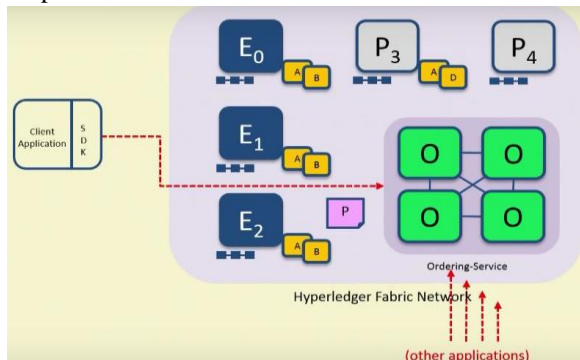
Step 3/7 : Proposal Response



Application receives responses

Read-Write sets are asynchronously returned to application. The RW sets are signed by each endorser, and also includes each record version number. (This information will be checked much later in the consensus process)

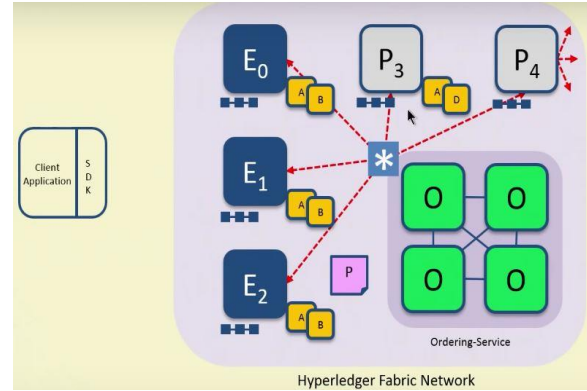
Step 4/7 : Order Transaction



Responses submitted for ordering

Application submits responses as a transaction to be ordered. Ordering happens across the fabric in parallel with transactions submitted by other applications.

Step 5/7 : Deliver Transaction



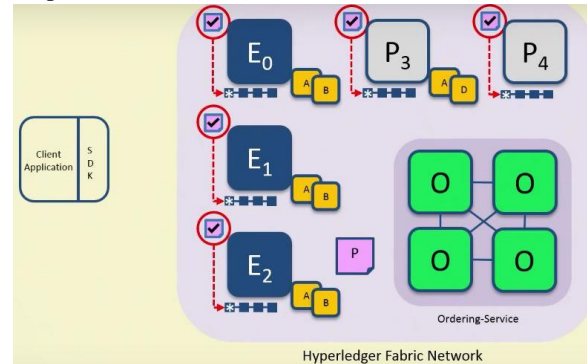
Orderer delivers to committing peers

Ordering service collects transactions into proposed blocks for distribution to committing peers. Peers can deliver to other peers in a hierarchy (not shown)

Different ordering algorithms available:

- SOLO (Single node, development)
- Kafka (Crash fault tolerance)

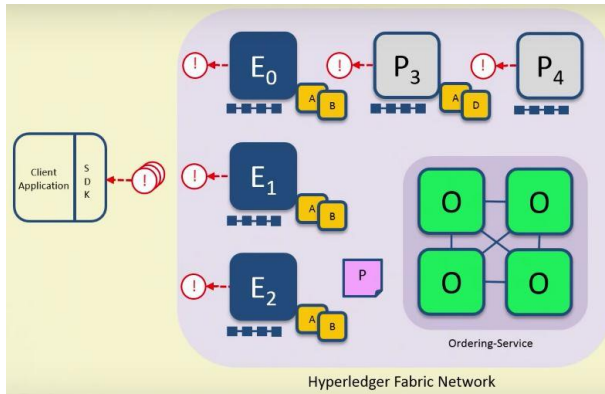
Step 6/7 : Validate Transaction



Committing peers validate transactions

Every committing peer validates against the endorsement policy. Also check RW sets are still valid for current world state. Validated transactions are applied to the world state and retained on the ledger. Invalid transactions are also retained on the ledger but do not update world state.

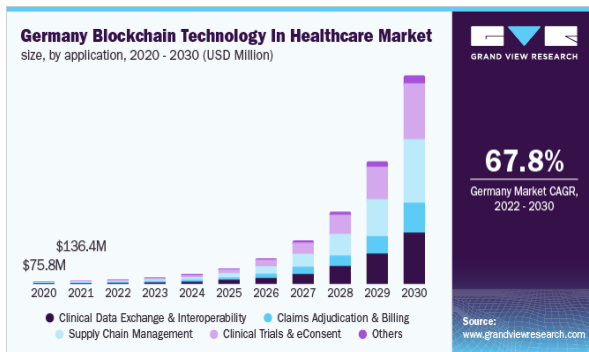
Step 7/7 : Notify Transaction



Committing peers notify applications

Applications can register to be notified when transaction succeed or fail, and when blocks are added to the ledger. Application will be notified by each peer to which they are connected.

STATISTICAL DATA OF BLOCKCHAIN TECHNOLOGY IN HEALTHCARE MARKET



USE CASES OF BLOCKCHAIN IN HEALTHCARE

- Secure Patient Healthcare Records : Blockchain technology can allow patients to access their care records by providing them with a security key that

matches their provider’s security key. Blockchain helps in gathering massive amounts of patient data and facilitates patient data sharing and improving interoperability to help population health initiatives. It also ensures the integrity of medical record by keeping it safe and unaltered.

- Making Patients Aware of Clinical Trials : Research has shown that 85% of patients were unaware of the relevant clinical trials during the time they were considering treatments which debarred them to benefit from treatments that the trials offered. Also, the inability of healthcare providers to recruit patients in need led to major loss of time and money spent on developing drugs. Distributed ledger in blockchain technology helped in increasing the quality and quantity of patients recruited for clinical trials by storing the medical data of patients anonymously and making it visible to trial recruiters which helped them to reach out qualified patients.
- Makes Claim Processing Easier: Today, there is no transparency and visibility between both the parties i.e. the healthcare stakeholders and the patient. Smart Contracts in blockchain improves data accuracy for providers, regulators, and other stakeholders, and give them more control of their own data which makes the processing of claims and payments efficient, secure and frictionless.
- Identifying and Matching Patients: In healthcare solving patient-matching is no less than a challenge. Blockchain is certainly a technology that can be used to track the unique patient identifier.

UNLOCKING THE BENEFITS OF BLOCKCHAIN TECHNOLOGY

Data Security: Blockchain is equipped with the latest cryptographic features that safeguard patient sensitive information and all medical data. It helps in checking the data authenticity with the help of digital signature and provides full protection to data.

Cost Savings: This ledger technology eliminates third-parties and banks by enabling peer-to-peer transactions which aid in lowering the transactional cost at a greater extent.

Increase in Patient Satisfaction: A blockchain platform coordinates patient records, a history of procedures,

and insurance claims to reduce redundancies and prevent losses. This helps healthcare providers to access medical history and insurance information and make quick decisions. This helps in improving the patient experience as well as the healthcare business model.

Accessing Distributed Data: Distributed ledger technology stores all the data in the nodes of a blockchain platform which allows hospitals, insurance companies, and patients to access the medical records from a single point which is secured enough and has full control that who should and shouldn't see the patient's data.

Healthcare Data Management: As aforementioned, if all the data has to be stored on a single point with open access will certainly add to woes and a severe threat to confidentiality. In such cases, permission blockchains such as Hyperledger Fabric or Corda set rules for giving permissions to companies to access the data.

Immutability: Data stored in the blockchain cannot be altered by anyone. Not even the admin, owner or third party.

CHALLENGES OF BLOCKCHAIN TECHNOLOGY IN HEALTHCARE

- Healthcare industry lacks structures to collect, share, and analyze information resulting in a lack of interoperability.
- Existing systems are managed in an off-line architecture, with centralized, local databases, whereas blockchain technology is decentralized and in the cloud.
- The inflated presence of healthcare units operating in off-line architecture, with centralized, local databases, makes it hard for existing systems to switch on blockchain, as the technology is decentralized and in the cloud.
- Interoperability challenges among various healthcare professionals and hospital systems result in a lack of coordinated data management and exchange, resulting in fragmented health records.

CONCLUSION

Thus we developed a solution in Hyperledger Fabric to Track Covid vaccine recipients so that no one is

misses or receives any extra dose. Care has been taken to bring in the light fake covid vaccine certificates and spot infected people who are spreading this further. Also we would get to know by this who got first shot and who got both the shots. So its an immutable solution where covid vaccine recipients can be tracked and updated as and when they receive the first or second shot.

REFERENCE

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