What is Hyperledger Fabric?

Hyperledger Fabric is an open-source platform for building distributed ledger solutions, with a modular architecture that delivers high degrees of confidentiality, flexibility, resiliency, and scalability. This enables solutions developed with fabric to be adapted for any industry. This is a private and confidential blockchain framework managed by the Linux Foundation.

How does Hyperledger Fabric Work?

Components:

- Hyperledger fabric is made up of various unique organizations or members that interact with each other to serve a specific purpose. These organizations are called members.
- Each member of the fabric can set up one or more authorized peers to participate in the network using the fabric certificate authority. All of these peers must be authorized properly.
- There is a client-side application connected to the network written with the software development kit (SDK) of any particular programming language.

Workflow:

For each and every transaction in the fabric, the following steps are followed-

- **Creation of the proposal:** The transaction begins when a member organization proposes or invokes a transaction request with the help of the client application or portal. Then the client application sends the proposal to peers in each organization for endorsement.
- **Endorsement of the transaction:** After the proposal reaches the endorser peers (peers in each organization for endorsement of a proposal) the peer checks the fabric certificate authority of the requesting member and other details that are needed to authenticate the transaction. Then it executes the chain code (a piece of code that is written in one of the supported languages such as Go or Java) and returns a response. This response indicates the approval or rejection of the following transaction. The response is carried out to the client.
- **Submission to ordering service:** After receiving the endorsement output, the approved transactions are sent to the ordering service by the client-side application. The peer responsible for the ordering service includes the transaction into a specific block and sends it to the peer nodes of different members of the network.
- **Updating the ledger:** After receiving this block the peer nodes of such organizations update their local ledger with this block. Hence the new transactions are now committed.

Hyperledger Fabric operates as a network of nodes, where each node performs a specific function, such as validating transactions, maintaining the ledger, and executing chaincode. Transactions are validated and ordered by a consensus mechanism, which ensures the integrity and consistency of the ledger.
The consensus algorithm in Hyperledger Fabric is pluggable, which means that it can be replaced with a different algorithm as needed.
The most commonly used consensus algorithms in Hyperledger Fabric are:

- **Practical Byzantine Fault Tolerance (PBFT):** PBFT is a consensus algorithm that provides fault tolerance and reliability in a network. It is well-suited for networks with a limited number of participants who are trusted and well-known.
- **RAFT:** RAFT is a consensus algorithm that is used to maintain a consistent state across multiple nodes. It is well-suited for networks where the participants are unknown and potentially untrusted.
- **Solo:** Solo is a consensus algorithm that is used for testing purposes in a single-node network. It is not suitable for production use.

Industry Use Cases For Hyperledger Fabric:

- **Supply Chain:** Hyperledger Fabric networks can improve the transaction processes of the supply chain by increasing the clarity and traceability of transactions within the fabric. Enterprises having authentication to access the ledger can view the data of the previous transactions which increases accountability and reduces the risk of counterfeiting of the transactions.
- **Trading and Asset Transfer:** Using Hyperledger organizations can transact and interact with each other in a paperless way and add the same layer of trust as the document signed by a trusted authority. This increases the performance of the system. The assets can also be dematerialized on the blockchain network with the help of Hyperledger fabric and traders can trade it anytime.
- **Insurance:** The insurance industry spends billions to avoid insurance frauds or falsified claims. With the help of Hyperledger fabric, the Insurance company can refer to the transaction data that is stored inside the ledger. Hyperledger Fabric can also make the processing of claims faster using the chain code and automate the payment.

Benefits Of Hyperledger Fabric:

- **Open Source:** It has an active community of developers and the code is designed to be publicly accessible. Anyone in the community can see, modify, and distribute the code as they see fit. People across the world can come and help to develop the source code.

- **Private and Confidential:** The identities of all participating members are authenticated and the ledger is only exposed to the authenticated members which is helpful for industries like banking, insurance, etc where customer data should be kept private.It is important to note that Fabric does not require all parts of a blockchain to be permissioned; the necessity for permissions is decided at the discretion of whoever designs the network.
- **Chaincode Functionality:** It's designed to support various pluggable components and to accommodate the complexity that exists across the entire economy. This is useful for some of the specific types of transactions like asset ownership change.
- **Performance:** There is no need to validate the transactions on this network so the transaction speed is faster, resulting in a better performance.
- **Channels:** Fabric provides the ability to partition ledgers into "channels," where members of the network may create a separate set of transactions that are not visible to the larger network. This allows for more sensitive data to be segregated from nodes who do not require access.
- **Modularity**: Fabric's architecture is designed to allow separate components to be added and implemented at different times. Many of the components are optional like the method of achieving consensus, membership services for identification, the ledger store itself, specific access APIs, and chaincode integration.

Limitation of Hyperledger Fabric:

Hyperledger Fabric is a robust and flexible platform for developing blockchain applications, but like any technology, it has certain limitations:

- **Scalability:** Hyperledger Fabric is designed for permissioned networks, where the participants are known and trusted, which can limit its scalability for large-scale public networks.
- **Performance:** The performance of Hyperledger Fabric can be impacted by factors such as network size, network configuration, and the complexity of chaincode, which can limit its ability to handle high volumes of transactions.
- **Complexity:** Setting up and configuring a Hyperledger Fabric network can be complex, requiring a deep understanding of the technology and its components.
- **Compatibility:** Hyperledger Fabric is designed to be used with specific programming languages, such as Go and JavaScript, which can limit its compatibility with other technologies and programming languages.
- **Cost:** Running a Hyperledger Fabric network requires infrastructure and resources, which can add costs to the deployment and operation of blockchain applications.
- **Interoperability:** Hyperledger Fabric is designed to be used within a single network, and its interoperability with other blockchain platforms is limited.