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Blockchain Network Based Hyperledger Fabric Techniques – A Survey

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Abstract

Blockchain is described as a cacheable, immutable that makes tracking transactions and assets in a corporate network easier. Hyperledger is a free software initiative that was designed to aid in the development of distributed ledgers based on blockchain technology. Hyperledger has several frameworks, including Hyperledger Fabric, Hyperledger Burrow, Hyperledger Indy, Hyperledger Sawtooth, and Hyperledger Grid. There are also other Hyperledger-based technologies used in blockchain. This research paper investigates the many applications and strategies employed by the Hyperledger Fabric blockchain network. There will also be a discussion regarding Hyperledger frameworks, future improvements, and overall applications used.

Keywords: Network security, fabric technology, hyperledger networks, transaction management, cryptographic

1. Introduction

Among all blockchain initiatives, Bitcoin [1] and Etheruem [2] have received the most media attention. However, blockchain technology infrastructure is not supported. So, other blockchain platform that is poised to become a major player in the blockchain space is Hyperledger. Hyperledger offers enormous promise for streamlining blockchain app development and making blockchain developers' life easier. The Linux Foundation established Hyperledger in 2016 to democratise and standardise blockchain technology for the commercial world. Initially, the Hyperledger Technical Steering Committee created two blockchain framework coding structures: Hyperledger Sawtooth and Hyperledger Fabric. Presently, the Hyperledger platforms are used in a variety of projects. Hyperledger is a fully accessible collaborative effort to improve blockchain technology across industries. It is a

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worldwide partnership of financial, banking, IoT, technology, manufacturing, and supply chain professionals. It provides a variety of projects and tools for blockchain developers to employ in order to create unique blockchain networks and applications. The objective is to make it easier for organisations and developers working in the Distributed Ledger Technology area to collaborate seamlessly (DLT). It enables enterprises to create unique blockchain apps to meet their specific blockchain requirements. Over 250 organisations worldwide already support the Hyperledger initiatives.

The Hyperledger Fabric framework is a permissioned infrastructure with a layered architecture that allows for the depiction of roles between infrastructure nodes, the completion of smart contracts, and predefined consensus and membership facilities. Fabric was created by a collaboration between IBM and digital asset. It was created primarily as an integration platform for creating highly available blockchain programs with DLT. Peer nodes and ordered nodes are utilised in a Fabric network. Peer nodes are thought to implement code, authorization of ledger data, complete transactions, and interact with apps. Ordered nodes are responsible for maintaining the blockchain's consistency and delivering accepted transactions to network peers.

Hyperledger has some other frameworks and tools. The Hyperledger frameworks are Hyperledger Burrow, Hyperledger Grid, Hyperledger Sawtooth and Hyperledger Indy. The Hyperledger tools used for different projects are Hyperledger Caliper, Hyperledger Cello, Hyperledger Composer, Hyperledger Quilt and Hyperledger Usra. Some of the Hyperledger frameworks and tools are discussed in detail to understand the importance of Hyperledger.

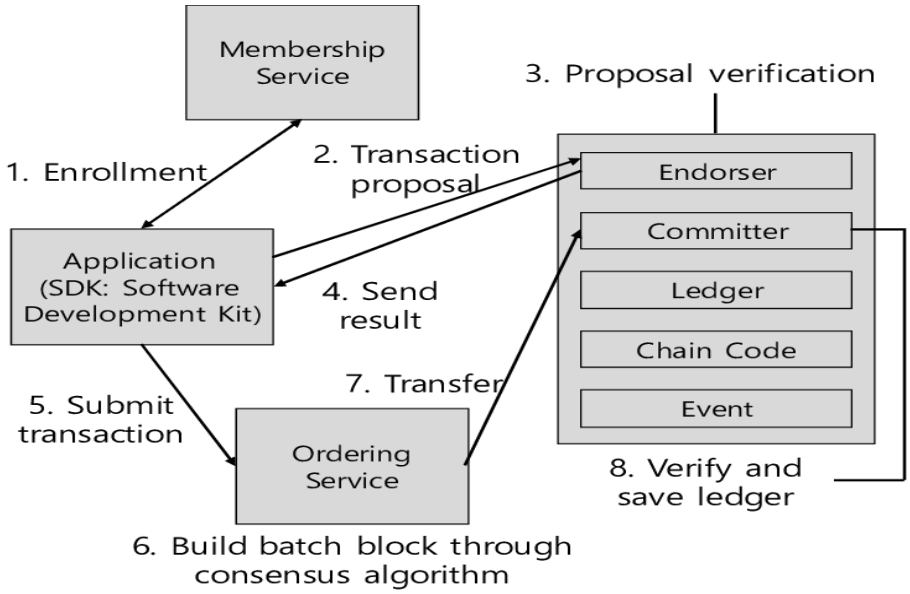

Figure 1. Architecture of Hyperledger Fabric [3]

1.1 Hyperledger Frameworks & Tools

Hyperledger manages a variety of frameworks and technologies. Smart contracts for public blockchains are built using Hyperledger frameworks. Some frameworks and tools are covered further below.

1.2 Frameworks

1.2.1 Hyperledger Burrow

Burrow is a Linux Foundation-hosted Hyperledger project. It enables a customizable blockchain client to create admissible smart contract machines using EVM [Ethereum Virtual Machine] specifications. Burrow claims to have a high transaction speed. Burrow is made up of several components, including an agreement engine, contract program, service blockchain connection, application binary interface, and API gateway.

1.2.2 Hyperledger Sawtooth

Sawtooth is a Hyperledger program that was started by Intel. It is a blockchain platform for enterprises that is used to build distributed ledger applications and networks. Its architecture separates the base system for the program domain, enabling smart contracts' entire safety. Sawtooth's dynamic consensus feature, which allows for hot-swapping consensus protocol in operating networks, is a distinguishing characteristic. Sawtooth supports Seth Ethereum Contract Compatibility. [Project Sawtooth - Ethereum Integration].

1.2.3 Hyperledger Grid

Hyperledger Grid is utilised for supply chain solutions. Grid was created to address supply chain issues, and it is one of the finest use cases for DLT. Grid is neither a blockchain framework nor a blockchain application. Grid, on the other hand, is an environment of frameworks, tools, and technologies that may enable developers to select relevant components for developing certain models. It pooled resources to accelerate the development of ledgers for inter supply chain solutions. It implements supply chain datatypes, flexible contractual business logics, and data models that adhere to industry best practises.

1.3 Tools

1.3.1 Hyperledger Caliper

The Hyperledger tool Caliper is hosted by the Linux Foundation. It computes the performance of certain blockchain implementations through the usage of a collection of pre-

defined use cases. It may also produce statistics on other performance metrics like as resource use, transaction latency, and transactions per second.

1.3.2 Hyperledger Composer

Composer is a developer's framework and toolkit meant to simplify the building of blockchain apps and smart contracts. It is used to swiftly design and deploy blockchain applications. Composer uses technologies like as Node.js, CLI, NPM, and others. These technologies are used to create business-related abstractions, example apps, and DevOps processes that are simple to test.

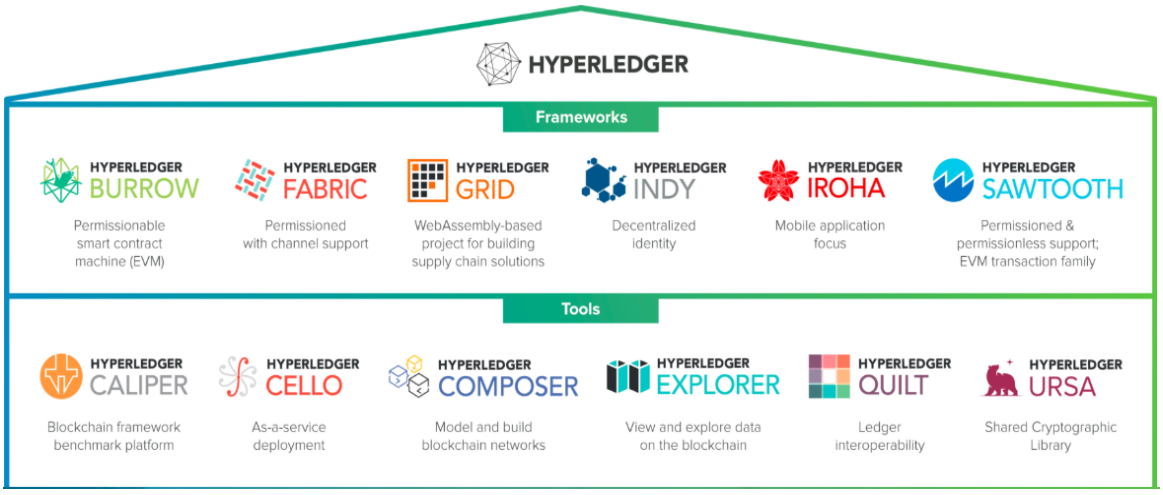

Figure 2. Hyperledger Frameworks and tools

1.3.3 Hyperledger Quilt

Quilt is a commercial blockchain application that intends to improve interoperability across ledger systems that use the interledger protocol (ILP). ILP is a payment mechanism that is used to transfer values across distributed and non-distributed ledgers. It also allows for atomic swaps across accounts and ledgers in a single account namespace.

2. Literature Survey

As a case study, Priyanka Gaba [4] investigated a blockchain-based VANET and implemented it by using the Hyperledger fabric. When the block size of a Blockchain-based VANET rises, the number of transactions, altering policies, and reads & writes in the transactions will increase. Block size has a significant impact on performance metrics like as latency, throughput, and network usage. The investigation for the VANET system demonstrates that there is no influence on throughput until the saturation threshold. However,

once the saturation threshold is reached, the larger block size increases throughput. The latency has changed in the same way as the throughput has. The latency increases the block size until it reaches saturation. After the saturation threshold, the latency decreases as the block size increases. Furthermore, when block size increases, so does the system's memory and CPU consumption. The suggested B-VANET technique was compared to existing Blockchain-based systems, and the results reveal that the proposed approach has concentrated on the reliance of performance analysis on block size, and endorsement policy is critical in achieving the highest potential performance.

This article [5], created a Hyperledger-based smart security control system for home. By offering effective access security and control for the computing device. The authorized device will gain access to the smart device through access control. During the entire operation, the security control is active and irregularly evaluating the validity of the configuration information. The Hyperledger fabric is utilised here due to the high performance requirements. The testing findings suggest that when the number of system registrations for smart home devices is smaller than 6,000 where the smart security control system performs better. These gadget will be investigated further in future study using data and applications from the security device.

This article [6] proposes a blockchain-based access control system (ABAC-HLFBC) that is totally decentralised, user-friendly, scalable, and interoperable with a variety of IoT-based access control models. The suggested model uses the Raft protocol technology rather than the Kafka ordering service that is employed in fabric-IoT [7]. Raft seeks to create a BFT ordering service with byzantine fault tolerance. The suggested model ABAC-HLFBC incorporates Hyperledger fabric ABAC, enables ABAC for chaincode, and contains configuration endorsement policy. The suggested model idea has been evaluated, and the experimental findings demonstrate that the proposed model outperforms the fabric-IoT in terms of cost, time, latency, and throughput. Improvement in outcomes as a result of the Raft ordering service's faster and less complex consensus and increased throughput.

In this paper [8], the author suggested Medical-Waste Chain, a decentralised blockchain-based system for autonomous waste treatment procedure for hospital equipment and providers after consumption. It is made up of four systems: medical equipment and suppliers, waste management centres, recycling facilities, and sorting factories. The author created a system model to ensure that medical waste creation is kept to a minimum. Then, using the Hyperledger tool caliper engine, analyse the performance of the suggested solution

using system-wide timings and latency analysis. Because it is built on a hybrid blockchain technology, it is flexible for the both on-chain as well as off additions. This method will upload the proof idea to the Github repository to promote future adoption.

Hai Trieu Le [9] designed, evaluated, and developed the Bloodchain system, which operates a blood collection network using blockchain technology. It does this by ensuring the visibility of blood information and providing assurance of blood safety for both recipients and donors. This protocol enables participants to track down the sources of blood quality using relevant metadata. Furthermore, the bloodchain eliminates forgeries and database manipulation, makes the blood managing process will help more visible by resolving issues in medical centers such as missing entrance, exit, and band faults. The bloodchain system facilitates blood transactions between medical facilities and can easily regulate blood quality, which benefits both recipients and donors. The bloodchain is used to demonstrate the efficacy of the suggested system.

Nabamita Deb [10] investigates the Hyperledger blockchain network, which allows for plaintext data processing and coarse-grained data access management. The author intends to use the BES-CP algorithm-based blockchain information access control mechanism. Depending on the user traits, this technique creates a fine-grained information access control system. Simultaneously, this research article builds on the basic fabric-CA depending on the Hyperledger network that provides support for the production of BES-CP algorithm key, which provides safe distribution. Finally, the security analysis of this article confirms that the solution's architecture enabled fine-grained access permissions for private data utilising the Hyperledger blockchain network, as well as protected distribution of private keys and data preservation.

Balamurugan. S [11] presented a Blockchain system based on IoT to track and prevent illicit goods from entering the supply chain of food. The proposed approach indicated that customers should be supplied the maximum product quality, which reduces the probability of food poisoning leading to human mortality. A decentralised network is constructed using the blockchain system, and quality testing is carried out in several networks. Real-time scanning programmes can be deployed, allowing the system to detect and remove illicit foodstuffs. Human civilization has also continued to employ the process of confirming food goods and recognising certified receipts via blockchain. The system efficiently monitored and evaluated the food traceability traceability approach, which was utilised to offer everyone with great food safety.

The integration of several streamflow data collecting systems is described by Muhammad Hussain Mughal [12]. The Hyperledger Fabric-based based on blockchain blockchain was utilised to ensure the consistency, immutability, and dependability of streamflow time – series analysis. The model accessed the Hyperledger fabric application using Pakistan's irrigation system, which has dispersed independent administrative authority.

The IPFS storage and sharing technique an unchangeable form of shared effective collaboration and operations such as the ORRFM semantic model, the water distribution agreement, and other policy and user manual This study will be expanded in the future to include micro-level distribution of water and the incorporation of water quality payment services via digital crypto-currencies. This strategy will increase and preserve e-governance productivity, transparency, traceability, and auditability.

Naresh Sammeta [13] created an HBESDM-DLD model for safe data transfer and diagnosis. SIMON block cipher-based encrypting, G-TOA-based optimum key generation, Hyperledger blockchain-based secure data management, and VAE-based diagnostics are all part of the proposed approach. The use of GTOA in the key generation process increases the security level of the health record transfer procedure. Simultaneously, Hyperledger blockchain provides health record management, allowing patients to obtain or deny access to any doctor or medical institution. Finally, the VAE-based diagnostic technique is used to assess the presence of illnesses. The experimental findings of the HBESDM-DLD models are studied utilising a medical dataset and several performance indicators. This approach will be expanded in the future to include metaheuristic optimization.

Chin-Ling Chen [14] proposed a Hyperledger fabric blockchain-based corporate privacy and data sharing scheme. The author concentrated on the security and privacy of data transmitted in industrial systems. They used the Hyperledger fabric process to verify and share the data while keeping sensitive data private. They isolated data in different channels, make transactions data will pass time stamps, and data will be transparent and traceable.

In addition, through the design of chaincode, a high level of automated processes in data was achieved. The under-chain storage technology significantly improves system scalability. Furthermore, this system offers mutual authentication among all system participants as well as data integrity protection. Finally, the results of the study demonstrate that this scheme has strong traceability, non-repudiation, and resilience to known cyber-attacks, as well as good performance.

Table 1. Hyperledger Fabric Blockchain Network - Survey Table

Reference	Application	Technique	Outcome	Benefits	Future Scope
Priyanka Gaba et al[4]	Hyperledger Fabric Private Blockchain Network (HFPBN)	*VANET *Hyperledger caliper *Blockchain	Optimal value achieved.	At saturation point, *Block size has no impact in throughput *Latency rises After saturation point, *Higher block size have higher throughput *Latency reduces.	Use B-VANET, *In crucial moment to achieve best possible performance
Lanfang Ren et al[5]	Fabric based smart home security control system	*Security control *Blockchain network	*The model works best when number of registration of smart home device under 6000.	Prevents security problems	Further studies on, *Data *Application Security of smart home services.
Elham A. Shammar et al[6]	*Attribute based Access Control in Hyperledger Fabric blockchain (ABAC-HLFB)	*Hyperledger Fabric Raft consensus mechanism *Hyperledger caliper benchmark tool	The model efficiently performs better than the metrics performance.	*User-friendly *User-transparent *Fault tolerance *Scalable *Compatible	To test security against access control attacks, *Forgery attacks *Injection attacks *man-in-the-middle attacks. *Intent to implement the model on more than one PC.
Khoi Le Quoc et al[8]	Hyperledger fabric technology	*Hybrid blockchain technology *Hyperledger caliper engine	Achieved and performed to prove effectiveness.	*Reusing medical equipment. *Recycle and schedule process to send & receive medical waste.	For authentication & authorization service, *Create more complicated methods.
Hai Trieu Le et al[9]	*Blockchain based – bloodchain *Hyperledger fabric	*Blood donation network *Private blockchain technology	The bloodchain system, *Designed *Developed *Evaluated	*Receivers felt safe-blood quality ensured. *Donors know their health.	Bloodchain perform Effectiveness
Nabamita Deb et al[10]	*Hyperledger blockchain	*BES-CP algorithm *Original fabric CA module	The security analysis and verification of the design is achieved.	*Secure distribution of user private keys *Data privacy protection	-Compare with schemes, *Achieve access control of Hyperledger network.
S Balamurugan et al[11]	*Blockchain Technology *Internet of Things	Blockchain supplier ledger technology	*Traceability of Food Supply Chain (FSC) *Monitor & analyze using IOT	*Improve data transparency *Enhance food safety *Reduce manual operation	Provided by blockchain, *Inherent durability *Ledger-based event tracking Can used in many domains.

Muhammad Hussain Mughal et al[12]	*Hyperledger fabric *Blockchain *Interplanetary File System (IPFS)	Pakistan's Irrigation Network	This technique resolves, *Conflict on streamflow optimization *Flood mitigation decisions	*Scalability *Transparency *Accessible of sharing data. *Availability	Through digital crypto currencies, *Micro-level water distribution *Integration-water consumption payment services.
Naresh Sammeta et al[13]	Hyperledger blockchain enabled secure medical data management in deep learning based diagnosis (HBESMD-DLD)	*SIMON block cipher technique *Group teaching optimization algorithm (GTOA) *Variational autoencoder based diagonstic model (VAE	Proves that HBESMD-DLD methodology is superior.	Data decrypted at receiving end, the VAE based diagnostic model detect the existence of the diseases.	HBESMD-DLD is extended to use, *meta-heuristic optimization based hyperparameter optimizer. *Learning rate schedule for VAE model.
Chin-Ling Chen et al[14]	*Hyperledger fabric blockchain based secure data scheme *Industrial Internet of Things (IIOT)	*Interplanetary File System (IPFS) *Elliptic Curve Digital Signature Algorithm (ECDSA)	Achieves mutual authentication of all parties in, *System *Data protection	Achieves good *Traceability *Non-repudiation *Resistance	To protect, *Banking nodes from attacks *The processing power of banking nodes. *To improve the transaction speed of whole blockchain network.

3. Conclusion

The blockchain serves as the basis for immutable ledgers, which are transaction records that cannot be changed, erased, or destroyed. The major feature is that it secures and protects datasets from threats while also allowing for speedier dataset settlement in time. Authentication mechanism, modular design, efficiency, and anonymity are all achieved using the Hyperledger Fabric Blockchain network. Hyperledger Fabric is superior to others because it allows for innovation and optimization across a wide variety of industry use cases. This survey research work is focused on the Hyperledger Fabric and focuses on blockchain network technologies, applications, and uses, as well as its future evolution in many ways. Blockchain technology's future applications will mostly focus on cyber security. We already know that the blockchain ledger is transparent and distributed, and that the data is safe and verifiable. Encryption is used to remove vulnerabilities such as unwanted data manipulation.

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