

# SEMINAR REPORT

ON

**Hyperledger Iroha: Business Blockchain Framework**

Submitted By

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Under the Guidance of

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## **CERTIFICATE**

This is to certify that **Pushkar Sunilkumar Nikumb** has successfully delivered seminar on **Hyperledger Iroha: A Business Blockchain Framework** under the guidance of **Prof. Dr. Y. D. Bhise**, towards the partial fulfilment of Bachelor's Degree in Computer Engineering of Savitribai Phule Pune University, Pune during Academic Year 2022-2023.

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Pushkar Sunilkumar Nikumb

# Abstract

A blockchain is a decentralized, peer-to-peer ledger that records and verifies all transactions on public networks. The ledger is replicated for each network member and records are synchronized. A ledger is maintained by a network of computers that perform complex mathematical calculations to validate transactions. Blockchain is commonly used to track Bitcoin and other cryptocurrency transactions.

## **About Hyperledger Foundation**

Hyperledger is a blockchain implementation based on open source software. Created by the Linux Foundation to accelerate the development of blockchain technology across industries. Hyperledger's main goal is to "promote and accelerate the development of open source blockchain technology".

This blockchain is aimed at all industries, not just financial institutions. It is an open-source blockchain that can be implemented in multiple industries such as finance, healthcare, supply chains, and manufacturing. Hyperledger technology enables a simple and secure world where once-complex and expensive transactions and interactions have unprecedented levels of trust and transparency.

## **What is Hyperledger Iroha?**

Iroha is a lightweight distributed ledger technology (DLT) inspired by the Japanese kaizen principle of eliminating muri. Iroha is an efficient, reliable, crash-fault-tolerant tool for your enterprise needs, as well as essential features for your asset, information, and identity management needs. Hyperledger Iroha is a novel blockchain technology for production use. It focuses mainly on the identification and financial services businesses. Hyperledger is designed for infrastructure projects that want to use distributed ledger technology.

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# Chapter 1

## Introduction

### 1.1 “Why does the Business and Financial Ecosystem require Blockchain?”

Blockchain is helping transform businesses around the world. Increased trust eliminates duplication of effort and increases efficiency. Blockchain is revolutionizing supply chain, food distribution, government, retail and more. Businesses are now using blockchain technology with strong cryptography to store and transmit records more securely.

### 1.2 “The rising significance of blockchain in the banking sector”

#### 1.2.1 The Importance of Technology

A. Elimination of Intermediaries : Blockchains provide transaction immutability and a distributed ledger architecture. This is a key enabler for eliminating the need for executors of trust in the ecosystem. Tamper-proof distributed data enables an environment



where trust is not an issue, trading partners always have the same version of the truth and can act with the knowledge that their story cannot be changed.

B. Transparency : Blockchain technology significantly improves transparency among market participants. Blockchain implementation facilitates the creation of a public record of ecosystem activity that can be accessed in real time by all market participants.

C. Origin : The blockchain maintains an immutable record of transactions, so ownership of an asset is preserved since it first appeared in a transaction on the blockchain. This significantly reduces the risk and the need for associated mitigation measures across multiple asset types. This feature helps reduce the incidence of theft, fraud, and unauthorized sale of high-value assets and intellectual property. It also helps assets whose provenance determines value by creating a digital footprint on the blockchain.

# Chapter 2

## Literature Survey

### 2.1 “An Overview of Hyperledger Foundation”

The Hyperledger Foundation exists to foster community development of enterprise grade open source blockchain, distributed ledger, and related technologies, and to drive broad adoption of these technologies. It hosts a wide array of software projects and the communities that develop and deploy them. Hyperledger technologies are transforming a wide range of existing markets and driving a growing list of new business models in emerging markets. According to research from Blockdata, Hyperledger technologies are used by more of the top 100 public companies in the world than any other blockchain platform. The Hyperledger Foundation is the open, global ecosystem for enterprise blockchain technologies. As part of the Linux Foundation, it is a neutral home for developers to collaborate, contribute, and maintain open source software.

#### **purpose of this paper**

This document provides a high-level overview of Hyperledger as an organization, including why it exists, what it does, and who is involved. Then it includes Hyperledger technologies and their impact on existing and new markets. End, This document looks at the roadmap for widespread adoption of Hyperledger platforms, tools and libraries to power a new generation of multi-party systems. This is not an in-depth technical whitepaper, but an introduction to Hyperledger for a general business reader.

## 2.2 “Hyperledger in Action Central Bank Digital Currency”

As central banks around the world have explored and researched the uses, viability, and needs for a central bank digital currency, Hyperledger’s distributed ledger technologies (DLTs) have been at the forefront of these experimentations. Thier DLTs, built in the open with vendor-neutral governance and currently deployed in several production networks in other sectors, provide proven technology with strong community support.

Central banks want to know that the technology they are using is sustainable, tested, and can withstand and adapt to the unique needs of this use case. We expect there will be many different DLTs used and explored for CBDCs and are proud to share these examples of how Hyperledger technology is leveraged and trusted for DLT-based CBDCs. We believe that for such an essential public good as digital cash, the technology that the future of money is built on should come from communities working together in the open, sharing ideas, knowledge, and lessons learned, to improve and test in a shared environment that everyone can benefit and learn from.

### **purpose of this paper**

This ebook provides the reader an overview of the Hyperledger Foundation, why open source development is appropriate for all central bank projects and real-life examples of CBDC projects around the world.

## 2.3 “The National Bank of Cambodia boosts financial inclusion with Hyperledger Iroha”

Central bank digital currency (CBDC) is a generic term for a third version of currency that could use an electronic record or digital token to represent the digital form of a nation’s currency. A CBDC is issued and managed directly by the central bank and

could be used for a variety of purposes by individuals, businesses, and financial institutions.

Creating a Central Bank Digital Currency (CBDC) is a journey into the unknown. Many of the world's central banks are looking for ways to get the most out of the economy. A cryptocurrency without flaws. Perhaps banks can mitigate risk by taking steps.

That is the job of the National Bank of Cambodia (NBC). central bank merged Collaborate with blockchain developer expert Soramitsu to modernize the country's traditional retail industry Payments using the Hyperledger Iroha blockchain framework. The project, called Bakong, is a smart first step in creating a fiat-backed digital currency. Individuals can now send money and shop at merchants using a simple smartphone Apartment merchants have access to a fast, cashless and secure payment system. and banks can do it Bank to bank transfers at a much lower cost. His pilot project started in July 2019 and ran successfully with over 10,000 users. or The next step is to let everyone in the country know that the system is available and working. This makes Bakong the world's first payment system like his CBDC.

# Chapter 3

## Topic Domain

### 3.1 Hyperledger Foundation

Hyperledger is an open source Consortium for developing Business Blockchain Technology hosted by Linux Foundation. Within Hyperledger Greenhouse, diverse communities collaboratively develop open source projects, that uniquely approaches Enterprise Blockchain Challenges

Hyperledger Iroha is a general purpose licensed blockchain system that can be used to manage digital assets, identities, and serialized data. This can be useful for applications such as interbank payments, central bank digital currencies, payment systems, national ID and logistics, and more. Their remaining goal is to create a DLT that allows groups to construct and run robust, industry-unique programs to guide personal commercial enterprise transactions. Launched in 2019, Hyperledger Iroha is one of the tasks evolved below the Hyperledger Umbrella, hosted through Linux Foundation The Japanese company, Soramitsu Co. Ltd., has open sourced the code for Iroha. This framework turned into evolved in C++ and helps a couple of languages like Java, Javascript, Swift, Python and a couple of O.S like Windows, Linux, macOS

## 3.2 Public v/s Private Blockchain Platforms

Hyperledger Iroha is different from other popular Blockchain platforms, like Bitcoin and Ethereum. These platforms/protocols are permissionless blockchain networks (Public Blockchain) where anyone can join and access through the network. In Iroha there is no native cryptocurrency. Instead, to meet business needs, interoperability with the system is allowed, meaning that only people with the required access rights can interact with the system. In addition, queries are also permissioned, so access to all data can be controlled.

In particular, a major difference from Ethereum is that Hyperledger Iroha allows users to perform common functions, such as creating and transferring digital assets, using predefined commands located in the system. This eliminates the need to write heavy, hard-to-test smart contracts, allowing developers to complete simple tasks faster and with less risk.

## 3.3 Key Features of Iroha

1. With this framework, you can program for multiple platforms (such as Android and mainframe systems) using programming languages such as Java, JS, Python, and iOS.
2. Multiple compatible operating systems including Windows, Linux and macOS.
3. Various built-in libraries make it easy to deploy and maintain.
4. Modular design based on the principle of separation of commands and queries.

# Chapter 4

## Technical Aspects

### 4.1 Architecture Flow

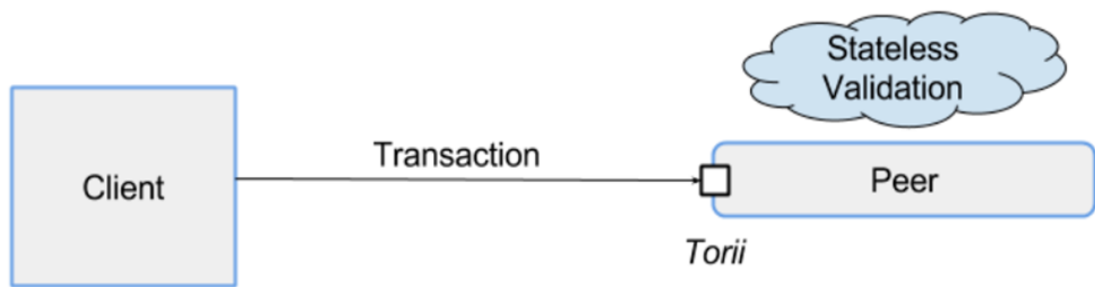


Figure 4.1: Client-Torii Connection

Step 1: Client performs transactions and sends to the Torii Gate, which routes the transaction to peer, responsible for performing Stateless Validation

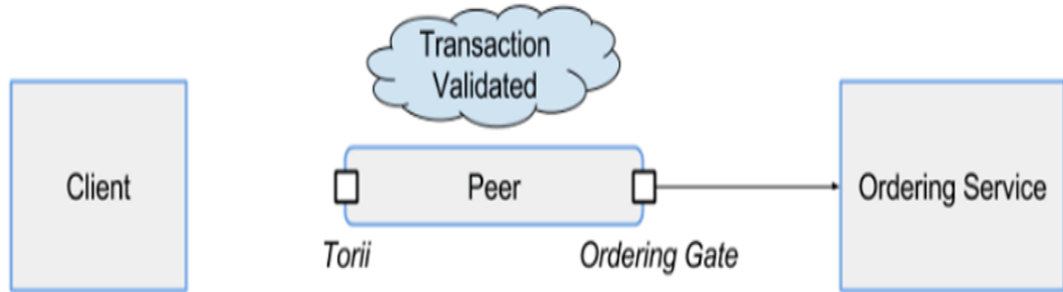


Figure 4.2: Transaction Validation

Step 2: After the peer performs Stateless Validation, the transaction is first sent to Ordering Gate which is responsible for choosing the right strategy for connecting the ordering services.

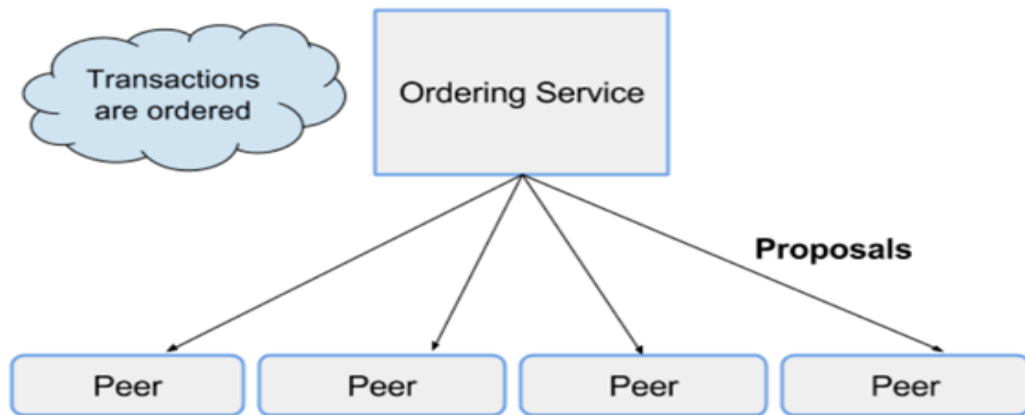


Figure 4.3: Ordering Transaction Gate

Step 3: Ordering service puts transactions into order and forwards them to peers in the Consensus Network in the form of Proposals. Proposal is an unsigned block shared by the ordering services, containing batch of Ordered Transactions



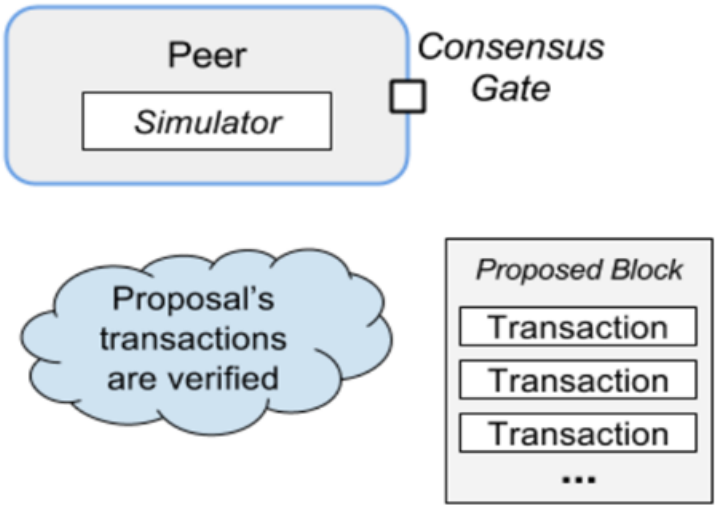


Figure 4.4: Validation of Transaction

Step 4: Each peer verifies the proposal's content in the simulator and creates a block which consists of verified transactions. Blocks are send to consensus gate which performs YAC Consensus logic

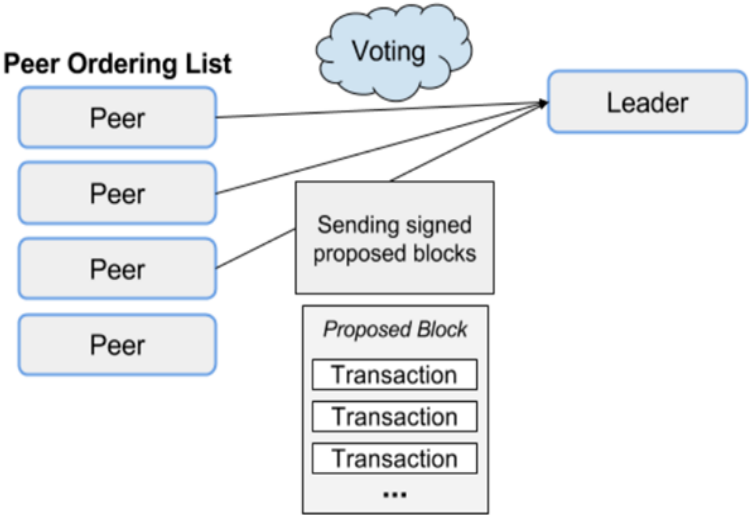


Figure 4.5: Peer Ordering List

Step 5: Order list of peers is determined and a Leader is elected based on the YAC

Consensus Logic. Each peer casts a vote by signing and sending their proposed block to the leader.

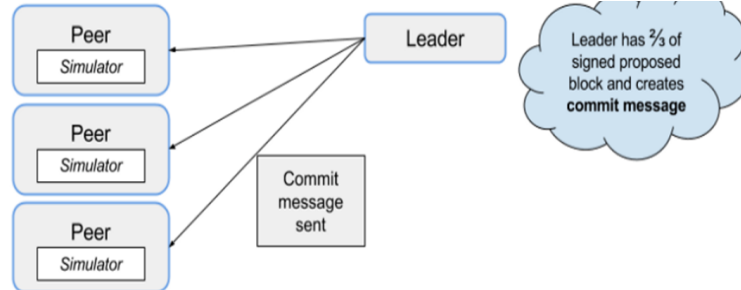


Figure 4.6: Commit Block

Step 6: Once the leader receives enough signed proposed blocks (2/3rd of peers), it starts to send a commit message, thus indicating blocks can be added to the database by applying a chain.

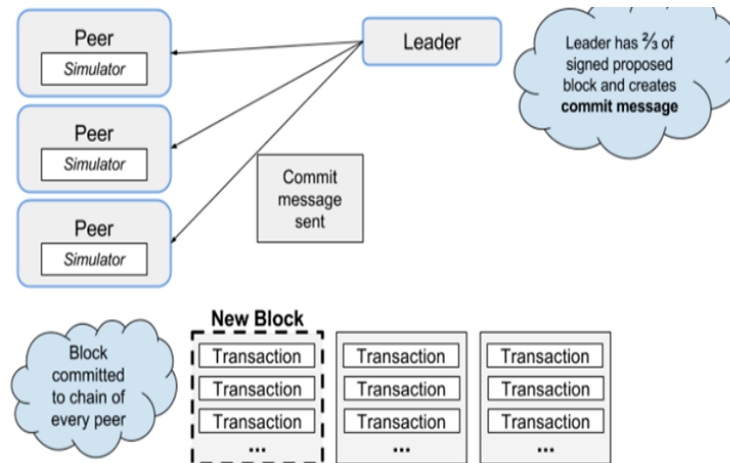


Figure 4.7: Add Block to Ledger

Final Step: Once the commit message has been sent, the proposed block becomes the next block in the chain of every peer via the Synchronizer.

## 4.2 Algorithm

Step 1: The ordering service shares a proposal to all peers. A proposal is an unsigned block created and shared to peers in the network by the ordering service. It contains a batch of ordered transactions.

Step 2: Peers calculate the hash of a verified proposal and sign it. The resulting `(Hash, Signature)` tuple is called a vote.

Step 3: Based on the hashes created in the previous step, each peer computes an ordering list or order of peers. To do this, the ordering function will need to have knowledge of all the peers voting in the network, and is based on the hash of the proposed block. The first peer in the list is called the leader. The leader is responsible for collecting votes from other peers and sending the commit message.

Step 4: Each peer votes. The leader collects all the votes and determines the supermajority of votes for a certain hash. The leader sends a commit message that contains the votes of the committing block. This response is called a commit.

Step 5: After receiving the commit, the peers verify the commit and apply the block to the ledger. At this point, consensus is complete.

## 4.3 Tools Technologies

We will create a very basic Iroha network, launch it, create a couple of transactions, and check the data written in the ledger. To keep things simple, we will use Docker. You need a machine with Docker installed. You can read how to install it on Docker's website.

### 4.3.1 Launching Iroha Client

#### 1. Starting Iroha Node

To operate, Iroha requires a PostgreSQL database or RocksDB. If you prefer PostgreSQL, you will need a container running it alongside Iroha.

Let's start with creating a Docker network, so containers for Postgres and Iroha can run on the same virtual network and successfully communicate. In this guide we will call it `iroha-network`, but you can use any name. In your terminal write following command:  
**`docker network create iroha-network`**

#### 2. Starting PostgreSQL Container

Now we need to run PostgreSQL in a container, attach it to the network you have created before, and expose ports for communication:

```
docker run --name some-postgres  
-e POSTGRES_USER=postgres  
-e POSTGRES_PASSWORD=mysecretpassword  
-p 5432:5432  
--network=iroha-network  
-d postgres:9.5  
-c 'max_prepared_transactions=100'
```

#### 3. Creating Blockstore

Before we run the Iroha container, we may create a persistent volume to store files, storing blocks for the chain. It is done via the following command:

```
docker volume create blockstore
```

## 4. Starting Iroha Container

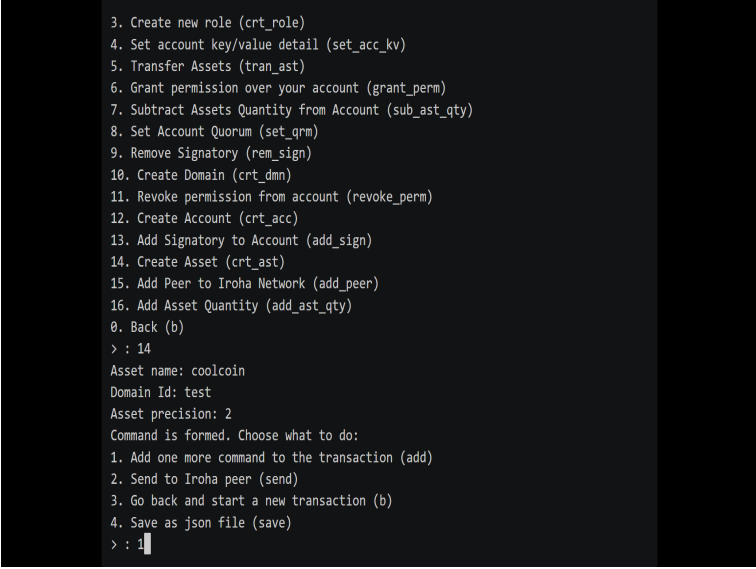
We are almost ready to launch our Iroha container. You just need to know the path to configuration files (from the step above).

Let's start Iroha node in Docker container with the following command:

```
docker run --name iroha
-d
-p 50051:50051
-v (pwd)/iroha/example/opt/iroha data
-v blockstore:/tmp/blockstore
--network=iroha-network
-e KEY='node0'
hyperledger/iroha:latest
```

### 4.3.2 Performing Transactions

#### 1. Creating Asset



```
3. Create new role (crt_role)
4. Set account key/value detail (set_acc_kv)
5. Transfer Assets (tran_ast)
6. Grant permission over your account (grant_perm)
7. Subtract Assets Quantity from Account (sub_ast_qty)
8. Set Account Quorum (set_qrm)
9. Remove Signatory (rem_sign)
10. Create Domain (crt_dmn)
11. Revoke permission from account (revoke_perm)
12. Create Account (crt_acc)
13. Add Signatory to Account (add_sign)
14. Create Asset (crt_ast)
15. Add Peer to Iroha Network (add_peer)
16. Add Asset Quantity (add_ast_qty)
0. Back (b)
> : 14
Asset name: coolcoin
Domain Id: test
Asset precision: 2
Command is formed. Choose what to do:
1. Add one more command to the transaction (add)
2. Send to Iroha peer (send)
3. Go back and start a new transaction (b)
4. Save as json file (save)
> : 4
```

Figure 4.8: Creating Asset

## 2. Add Asset Quantity

```
> : 1
-----
Choose command to add:
1. Detach role from account (detach)
2. Add new role to account (apnd_role)
3. Create new role (crt_role)
4. Set account key/value detail (set_acc_kv)
5. Transfer Assets (tran_ast)
6. Grant permission over your account (grant_perm)
7. Subtract Assets Quantity from Account (sub_ast_qty)
8. Set Account Quorum (set_qrm)
9. Remove Signatory (rem_sign)
10. Create Domain (crt_dmn)
11. Revoke permission from account (revoke_perm)
12. Create Account (crt_acc)
13. Add Signatory to Account (add_sign)
14. Create Asset (crt_ast)
15. Add Peer to Iroha Network (add_peer)
16. Add Asset Quantity (add_ast_qty)
0. Back (b)
> : 16
Account Id: admin@test
Asset Id: coolcoin#test
Amount to add (integer part): 20050
Amount to add (precision): 2
```

Figure 4.9: Add Asset Quantity

## 3. Transferring Assets

```
-----
Choose command to add:
1. Detach role from account (detach)
2. Add new role to account (apnd_role)
3. Create new role (crt_role)
4. Set account key/value detail (set_acc_kv)
5. Transfer Assets (tran_ast)
6. Grant permission over your account (grant_perm)
7. Subtract Assets Quantity from Account (sub_ast_qty)
8. Set Account Quorum (set_qrm)
9. Remove Signatory (rem_sign)
10. Create Domain (crt_dmn)
11. Revoke permission from account (revoke_perm)
12. Create Account (crt_acc)
13. Add Signatory to Account (add_sign)
14. Create Asset (crt_ast)
15. Add Peer to Iroha Network (add_peer)
16. Add Asset Quantity (add_ast_qty)
0. Back (b)
> : 5
SrcAccount Id: admin@test
DestAccount Id: test@test
Asset Id: coolcoin#test
Amount to add (integer part): 10050
Amount to add (precision): 2
```

Figure 4.10: Transferring Assets

#### 4. Sending Assets to Local Peer

```
0. Back (b)
> : 5
SrcAccount Id: admin@test
DestAccount Id: test@test
Asset Id: coolcoin#test
Amount to add (integer part): 10050
Amount to add (precision): 2
Command is formed. Choose what to do:
1. Add one more command to the transaction (add)
2. Send to Iroha peer (send)
3. Go back and start a new transaction (b)
4. Save as json file (save)
> : 2
Peer address (0.0.0.0): localhost
Peer port (50051): 50051
[2018-03-22 15:30:49.547815338][th:43][info] TransactionResponseHandler Transaction successfully sent
Congratulation, your transaction was accepted for processing.
Its hash is 73c1abd8d9aee68b61ebe19313b6ca0a51cf177aa8dc8a82f632aa6846abc5b4
-----
Choose what to do:
1. New transaction (tx)
2. New query (qry)
3. New transaction status request (st)
> : 2
```

Figure 4.11: Sending Assets to Local Peer

#### 5. Asset Received Successfully

```
0. Back (b)
> : 7
Requested account Id: test@test
Requested asset Id: coolcoin#test
Query is formed. Choose what to do:
1. Send to Iroha peer (send)
2. Save as json file (save)
0. Back (b)
> : 1
Peer address (0.0.0.0): localhost
Peer port (50051): 50051
[2018-03-22 15:31:24.458271984][th:43][info] QueryResponseHandler [Account Assets]
[2018-03-22 15:31:24.458310464][th:43][info] QueryResponseHandler -Account Id:- test@test
[2018-03-22 15:31:24.458320160][th:43][info] QueryResponseHandler -Asset Id- coolcoin#test
[2018-03-22 15:31:24.458353743][th:43][info] QueryResponseHandler -Balance- 100.50
-----
Choose what to do:
1. New transaction (tx)
2. New query (qry)
3. New transaction status request (st)
> :
```

Figure 4.12: Asset Received Successfully

# Chapter 5

## Application

### 5.1 Certificates in Education, Healthcare

Hyperledger Iroha integrates multiple certification bodies such as universities, schools, and medical institutions into the system. The flexible permissions model used by Hyperledger Iroha allows the creation of authentication identities and the granting of certificates. Various reputation and identity systems can be built by storing explicit and implicit information in user accounts.

Hyperledger Iroha can be used to verify that any educational or medical certificate was issued by a specific certification authority. Immutability and clear validation rules ensure transparency in healthcare and education, greatly reducing the use of fake certificates.

### 5.2 Cross-Border Asset Transfers

Hyperledger Iroha provides fast and clear trade and settlement rules using multi-signature accounts and atomic exchange. Asset management is easy as in centralized systems while providing necessary security guarantees. By simplifying the rules and commands required to create and transfer assets, we



lower the barrier to entry, while at the same time maintaining high-security guarantees.

## 5.3 Financial Applications

Hyperledger Iroha is very helpful in the audit process. All information is validated by business rules and maintained constantly by various network participants. Access control rules and some encryption maintain the desired level of privacy. Access control rules can be defined at various levels, such as user level, domain level, or system level. At the user level, data protection rules are defined for a specific person. When an access rule is set at the domain or system level, it affects all users within the domain. Hyperledger Iroha provides practical role-based access control rules with specific privileges for each role.

Transactions can be tracked using the local database. Auditors can use her Iroha API to query data and perform analysis, as well as run specific audit software. Hyperledger Iroha supports different scenarios for deploying analytics software (running code on specific middleware on your local machine). This approach enables analytics for big data applications using Hadoop, Apache, and more. Hyperledger Iroha ensures data integrity and privacy (by restricting query privileges).

## 5.4 PROJECT BAKONG

### 5.4.1 Acknowledging the country's banking project

In the Kingdom of Cambodia in Southeast Asia, three-quarters (78 percent) of its residents don't have any financial institution account, but more than

1/2 of them own a cellphone.

And despite the fact that the local currency—the Khmer riel (KHR)—has been strong for 20 years, maximum humans there use the U.S. dollar. Ever because of a primary UN project withinside the mid-1990s, the fee of the whole thing from a cup of espresso to a vehicle has been given in U.S. dollars.

Converting a fee to KHR entails multiplying via way of means of a component of 4,075: now no longer the handiest calculation to do in a hectic market. For a while, the NBC had desired to “de-dollarize” the retail segment; in different words, to regain control of the country’s currency.

Central banks have a tendency to be aware of wholesale settlements among home banks. But while diverse banks and 0.33 events use specific retail banking systems, those regularly do not speak properly with one difference.

The NBC questioned if allotted ledger technology (DLT) should assist remedy all of those problems. Could a blockchain-primarily based totally gadget deal with transactions quicker and for a lower fee than the prevailing gadget? Could that sell wider use of the riel? And should that gadget run as a cellular app that any citizen with a cellphone should use to keep or switch cash to own circle of relatives or friends?

### 5.4.2 Choosing the Best Platform to Use

#### Hyperledger Iroha

For central banks, privacy is important, but anonymity is not. Also important is the assurance that the funds can only be used once.

NBC was looking for a blockchain system that could provide:

#### Confirmed Transaction Finality:

Transactions, once confirmed, had to remain immutable to protect the integrity of all accounts.

#### Byzantine Fault Tolerance (BFT):

To ensure system continuity even if one or more nodes are compromised or taken offline, this approach is required for systems to come to consensus.

**Account Management System:**

allows the balance of all accounts in the general ledger to be reconciled on a transaction-by-transaction basis, allowing banks to easily monitor transactions.

**5.4.3 Simplified Architecture**

This results in a smaller attack surface, fewer vulnerabilities, and easier protection and maintenance of the system. After defining these requirements, the central bank considered four different blockchain platforms. Hyperledger Iroha met the bank's needs better than any other platform.

Hyperledger Iroha has a simple architecture with a role-based, account-based permissions system and many predefined commands that save time and increase security.

For transaction finality, Hyperledger Iroha uses a pragmatic BFT algorithm based on the Yet Another Consensus (YAC) Consensus: Block Hash Voting.

# Chapter 6

## Summary

Through the journey of choosing a topic, presenting Seminar and generating Report, I studied a new Blockchain Framework that has a lot of potential to expand its diversity in Multiple domains like Finance, Banking, Supply Chains, etc. Hyperledger Iroha is a versatile and especially a Business Blockchain Framework designed to be incorporated in various Business uses and Infrastructure projects that need Distributed Ledger Technology. Hyperledger Iroha provides

1. Reliability (fault tolerance, recoverability).
2. Performance Efficiency (in particular time-behavior and resource utilization).
3. Usability (learnability, user error protection, appropriateness recognisability).

This report consists of all the key concepts that could describe this Framework. Why we required blockchain and its frameworks and how Hyperledger Iroha (evolved below Hyperledger umbrella) can be used to create platforms (especially business oriented applications). The Architecture of this framework performs transactions in peer-to-peer Network (which is permissioned Blockchain) and maintains the records using Decentralized Oracle Networks.

# Bibliography

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