



# PANIMALAR ENGINEERING COLLEGE



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CS8811 PROJECT WORK

REVIEW NO:1

## Implementing Core Functionalities of PDS using Hyperledger Fabric

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**BATCH NO: E18**

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# Introduction

1. Public Distribution System is an essential scheme envisioned for distribution of food commodities to the public at subsidized rate.
2. Central Government and State Government shares the responsibility for distribution by procuring from farmers, processing, storing and selling to consumers at subsidized rate through Fair Price Shops.
3. PDS has leakages and many shortcomings.
4. The project is aimed to eradicate leakages and diversions in the scheme with the help of asset tracking using RFID and distributed immutable ledger.

# Literature Survey

Author	Title	Source	Findings
Satoshi Nakamoto (2008)	Bitcoin: A Peer-to-Peer Electronic Cash System	www.bitcoin.org	In Bitcoin, Blockchain is used to store the transactions in various public peers by reaching consensus through proof of work where every peer competes each other to append block of transactions to the ledger
Melanie Swan (2015)	Blockchain Blueprint for a New Economy	O'Reilly Media	Blockchain acts as a trustful system between various parties which helps in various use cases for eliminating redundancy and unnecessary intermediaries.
GUIDO PERBOLI, STEFANO MUSSO, MARIANGELA ROSANO (2018)	Blockchain in Logistics and Supply Chain: A Lean Approach for Designing Real-World Use Cases	IEEE	GUEST (GO, UNIFORM, EVALUATE, SOLVE AND TEST) methodology can be applied to formulate blockchain designs for specific Supply Chain Management and Logistics use case
Reshma Kamath (2018)	Food Traceability on Blockchain: Walmart's Pork and Mango Pilots with IBM	The JBBA	Walmart is solving the challenges in logistics and supply network using IBM's blockchain solution. It successfully tried two blockchain test pilots on pork from China and mangoes from America.
Giorgio Alessandro Motta, Bedir Tekinerdogan and Ioannis N. Athanasiadis (2020)	Blockchain Applications in the Agri-Food Domain: The First Wave	www.frontiersin.org	Tuna Tracking and Certification by Provenance, Olive Oil Tracking by Ambrosus, Celeia Dairy by OriginTrail, Pork Meat Traceability by TE-Food, FoodCoin and Wine Blockchain by EZLab. Ambrosus architecture is based on Amber.
Kok Yong Chan, Johari Abdullah, Adnan Shahid Khan (2019)	A Framework for Traceable and Transparent Supply Chain Management for Agri-food Sector in Malaysia using Blockchain Technology	IJACSA	Research was conducted in Malaysia to design and test traceable supply chain management system for pepper. The blockchain system was designed to encompass various actors like Farmers, Processors, Distributors, Retailers, Customers, and it was code-named as Prochain.

**Table 1. Literature Survey Table on Blockchain**

# Problem Statement

1. Accountability of consignment is not ensured, and essential supplies are sold in black market to other districts
2. Traditional system is built using JSP and Struts framework. SMS gateway of NIC is interfaced with this system.
3. In 4G era, GPRS and SMS is still used in existing tracking facility. GSM spoofing (or) misuse of registered mobile number can lead to malfunction of this traditional system.
4. This is a manual process prone to human errors and inaccuracies. Accountability and Trust of the systems involved in the process can be breached

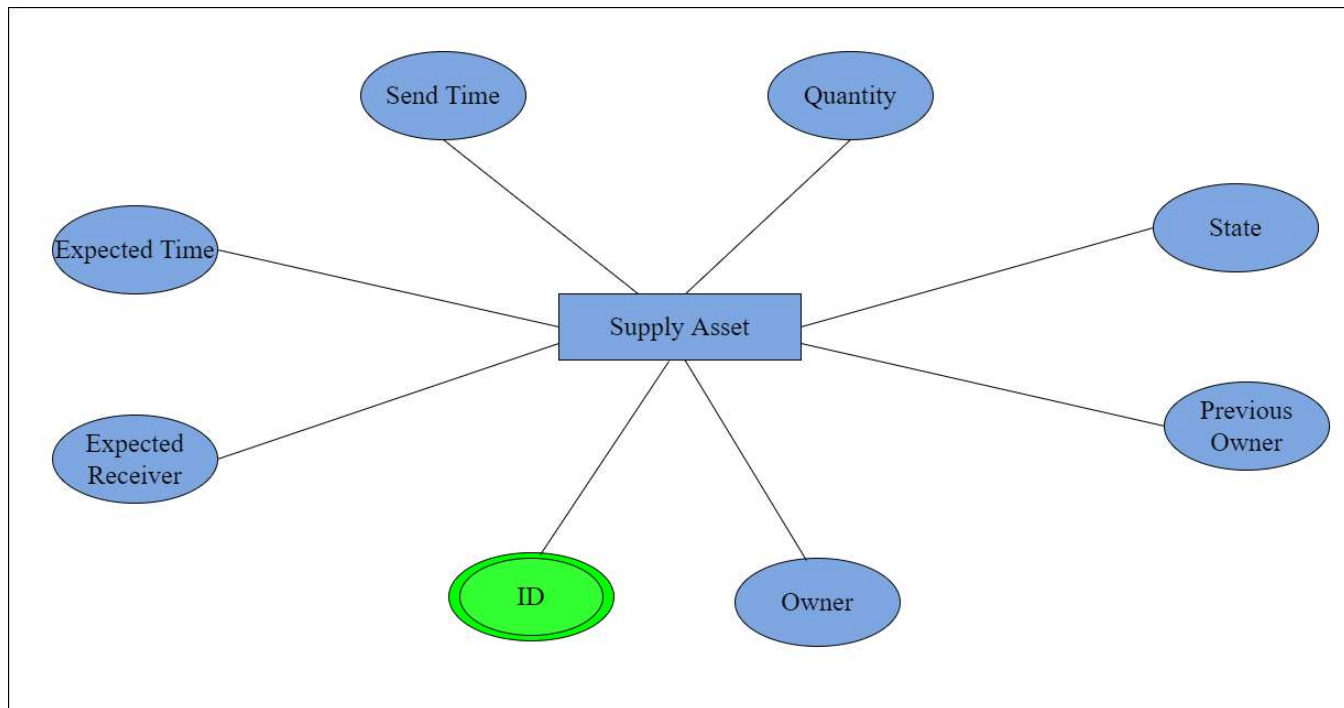
# Development Environment (S/W & H/W)

1. Hyperledger Fabric Framework for setting up permissioned blockchain network and running chain code in the peer nodes.
2. Go/NodeJS for writing chain code and setting up REST APIs.
3. RFID Tags and Receiver for Asset Creation and Identification.
4. Embedded HTML forms for accessing REST APIs to CRUD assets.
5. ESP8266 and RC522 for IoT Implementation.

# System Architecture

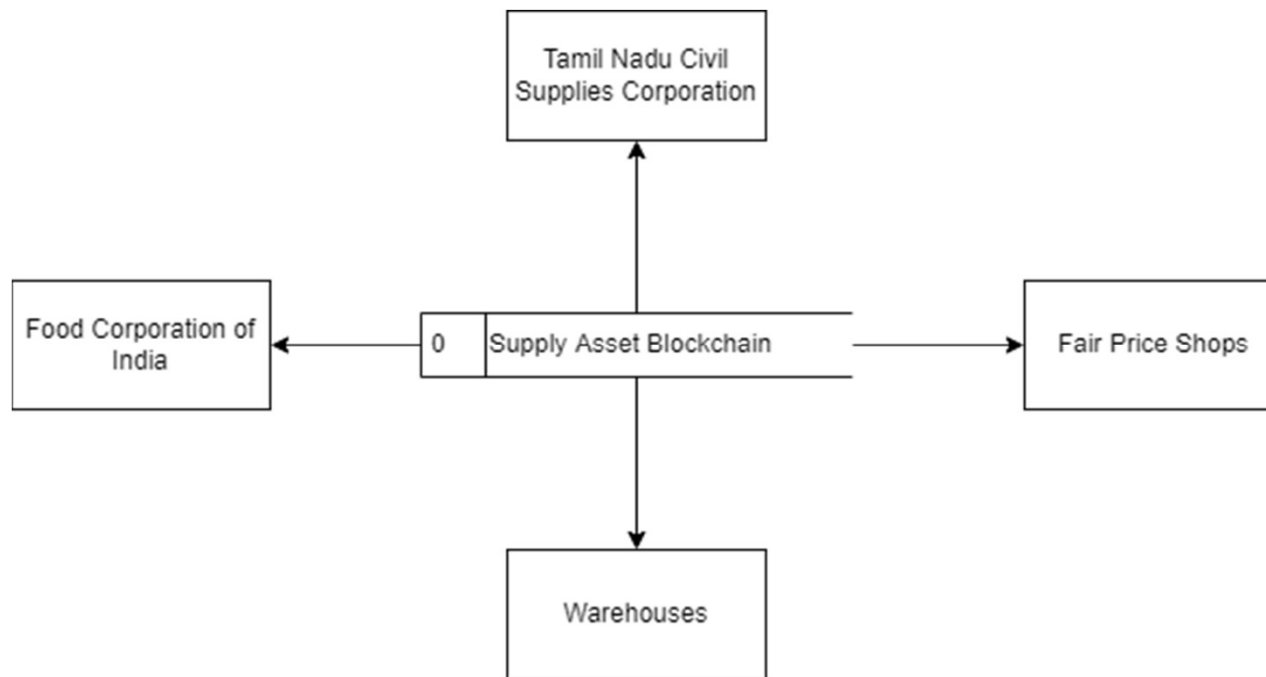
1. Based on extensive literature review and observed research gaps, a blockchain framework has been proposed to connect Ministry of Food and PDS , FCI, central, state and leased warehouses, FPSs throughout India and the beneficiaries.
2. The permissioned blockchain system, where consensus is controlled by participants and read permission is with participants only will be appropriate.
3. The consensus protocol refers to the method of verifying the legitimacy of the block of transactions. Consensus protocol of Proof of Authority could be used where the authority to verify the blocks will be with specified participants such as FCI, Ministry, warehouses and registered FPS

# System Design (ER Diagram)



**Figure 1. ER Diagram**

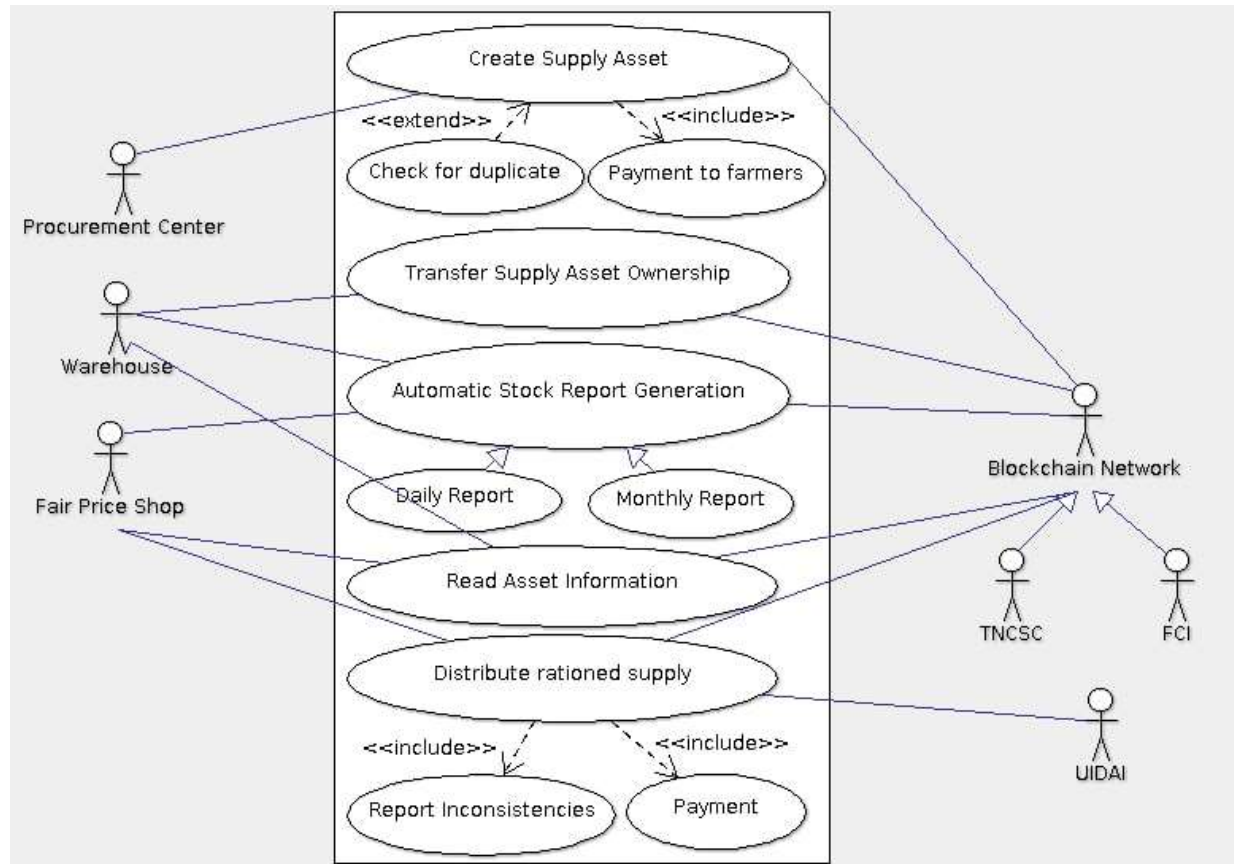
# System Design (DFD Diagram)



**Figure 2. DFD Diagram**

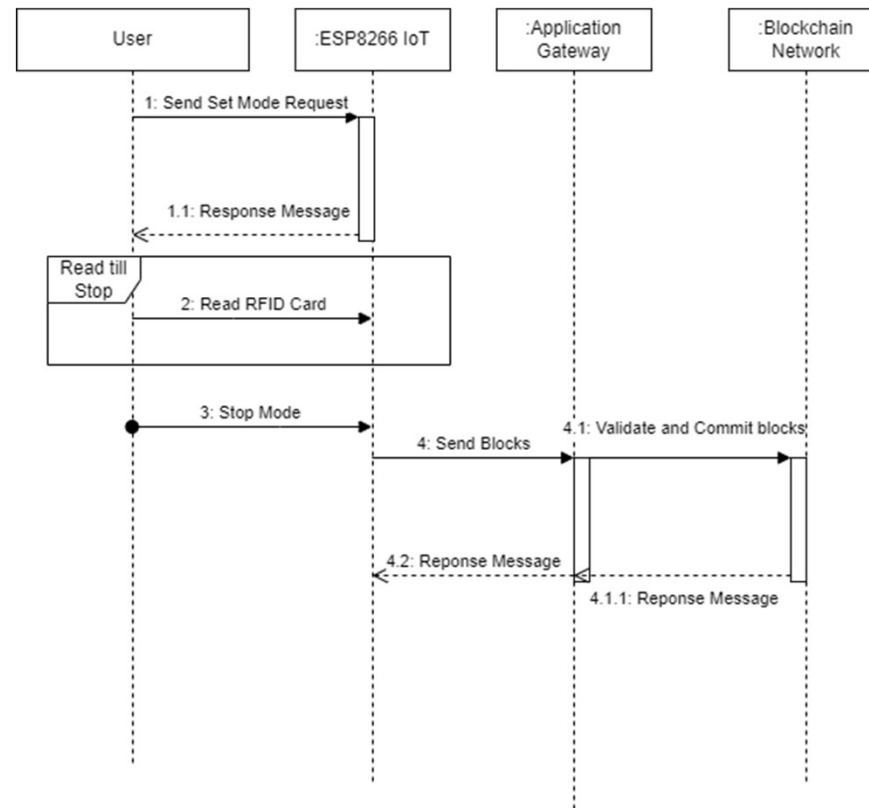


# System Design (Use Case Diagram)



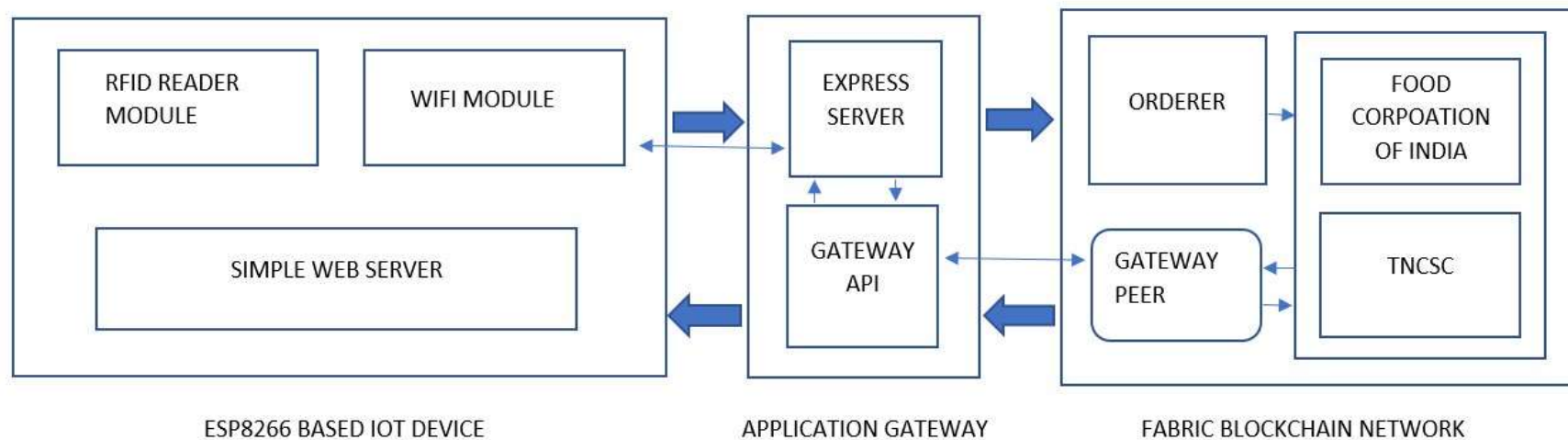
**Figure 3. Use Case Diagram**

# System Design (Sequence Diagram)



**Figure 4. Sequence Diagram**

# Module Description



**Figure 5. Overall Module Diagram**

# Module Description

- Three Important Modules are discussed below with the explanation of sub modules confined within those main modules.

## **1. ESP8266 BASED IOT DEVICE**

## **2. APPLICATION GATEWAY**

## **3. FABRIC BLOCKCHAIN NETWORK**

# Module Description

## ESP8266 Based IoT Device:

- ESP8266 is a low-cost micro controller with inbuilt Wi-Fi transceiver module.
- ESP8266 is immensely useful because it can get the RFID information and call Chain code API to add the assets in the blockchain because ESP8266 is connected to Wi-Fi, and it can handle asynchronous requests.
- Program is written to communicate with RC522 to get the RFID tag information. RC522 is interfaced with help of SPI communication

# Module Description

- There are four pins involved in this Serial Peripheral Interfacing. They are Master Out Slave In (MOSI), Master In Slave Out (MISO), Serial Clock (SCK), Signal Input. There are three other pins used for connecting to Power Supply (VCC, GROUND, RESET).
- RC522 is a low-cost RFID reader which reads RFID Tags with the help of 13.56Mhz EM waves.
- Web Server is deployed on ESP8266 to host a simple web page. This is used to set various modes on IoT device (Create, Transfer Ownership, Read).
- Mobile/PC can connect with this website for CRUD operations

# Module Description

## Application Gateway:

- Application Gateway is required to make a way for IoT devices to connect with Blockchain Framework SDK.
- It is designed in a form of REST API endpoints, and this makes sure that it is stateless and highly scalable as it is of microservice architecture.
- This acts like a barrier because IoT doesn't directly interact with Fabric SDK, and this ensures that malicious requests are avoided before reaching Fabric

# Module Description

## Fabric Blockchain Network:

- Hyperledger Fabric is a permission blockchain framework through which multiple parties can collaborate and transact with the help of distributed immutable ledger.
- This framework is used to form a distributed network of peers across multiple organizations and these peers will be running smart contract and maintaining the blockchain.
- Fabric Blockchain is deployed in every peer, and it is composed of World State and Ledger.

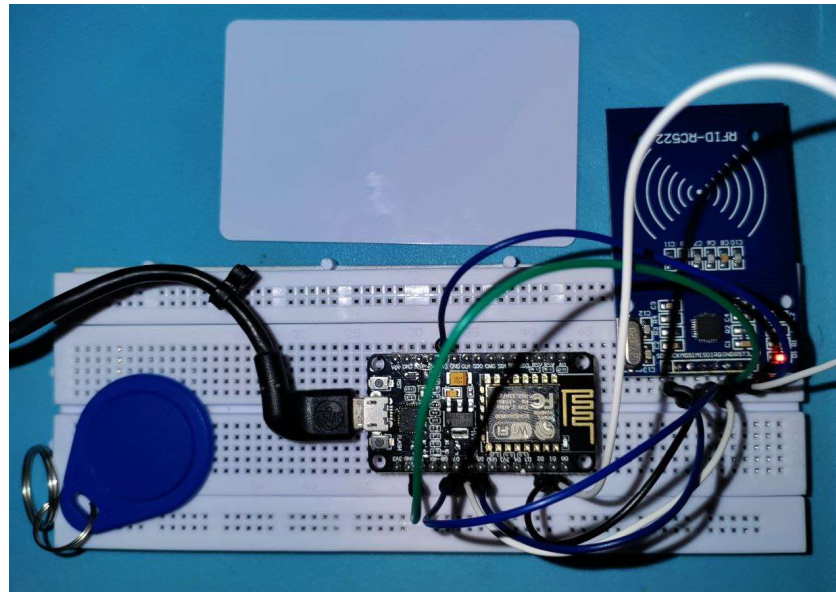


# Module Description

- Trust and Consensus between several peers is reached using Crash Fault Tolerance Protocol (CFT).
- Ordering Service is an integral part of CFT protocol which will be validating the block of transactions before getting appended into the ledger.
- Execute-Order-Validate architecture is used in Fabric framework instead of Order-Execute. Transaction proposal is sent from application to peers to get validated so that peers execute and sends endorsed transaction response. Endorsed transactions collected from the peers are send to ordering service by application.

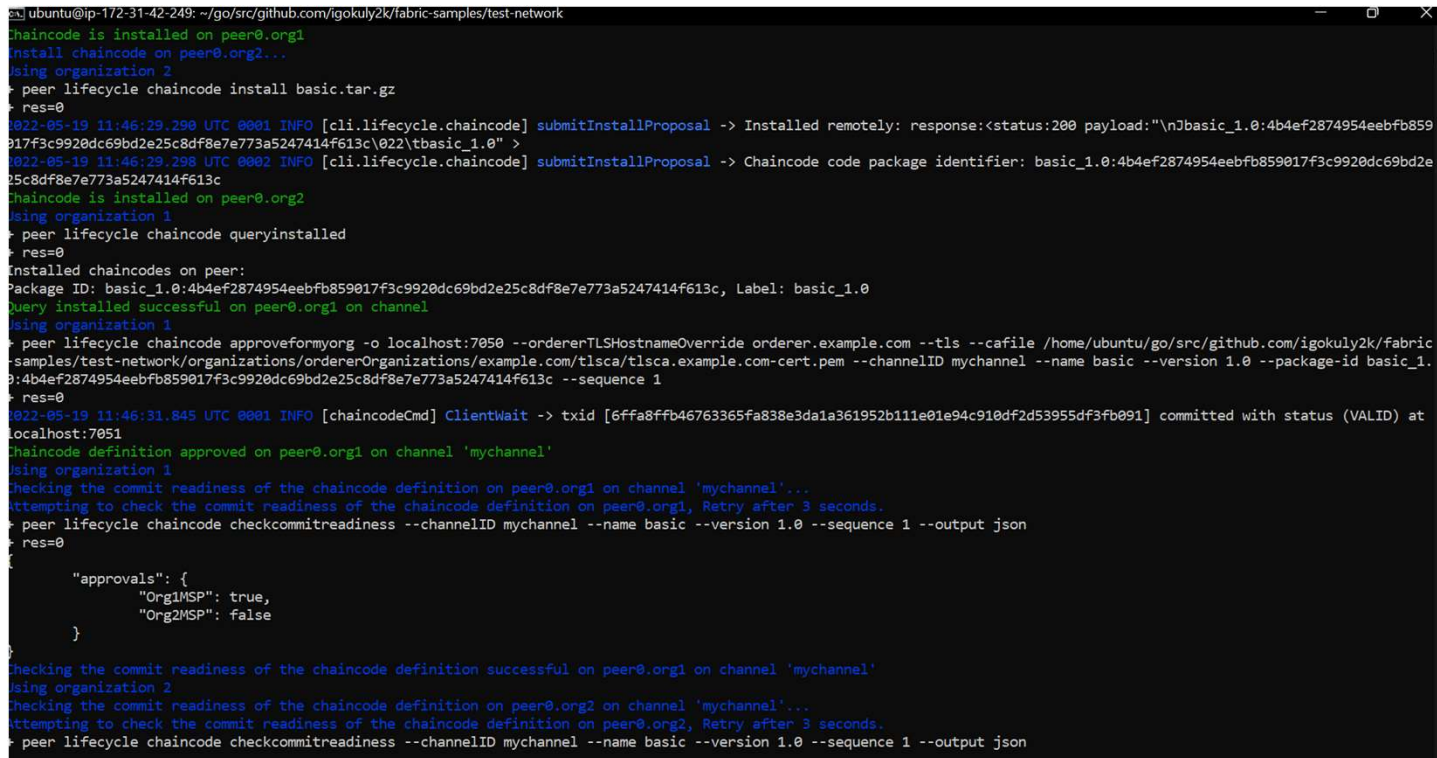
# Results

From the obtained test cases and results above, we could infer that the proof of concept made possible using Hyperledger Fabric is working as expected.



**Figure 6. ESP8266 IoT Setup**

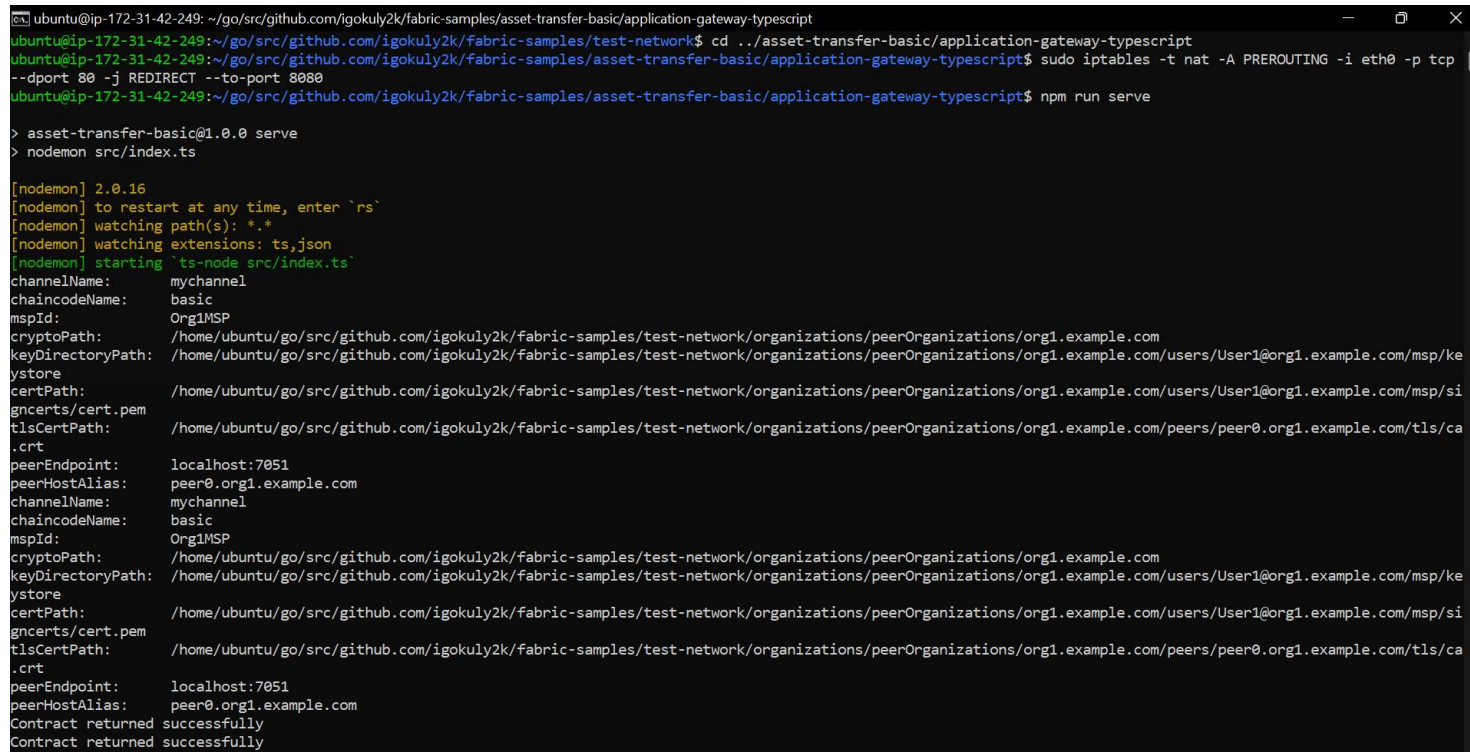
# Screenshots



```
ubuntu@ip-172-31-42-249: ~/go/src/github.com/igokuly2k/fabric-samples/test-network
chaincode is installed on peer0.org1
Install chaincode on peer0.org2...
Using organization 2
peer lifecycle chaincode install basic.tar.gz
res=0
2022-05-19 11:46:29.298 UTC 0001 INFO [cli.lifecycle.chaincode] submitInstallProposal -> Installed remotely: response:<status:200 payload:"\nJbasic_1.0:4b4ef2874954eebf859017f3c9920dc69bd2e25c8df8e7e773a5247414f613c\022\tbasic_1.0" >
2022-05-19 11:46:29.298 UTC 0002 INFO [cli.lifecycle.chaincode] submitInstallProposal -> Chaincode code package identifier: basic_1.0:4b4ef2874954eebf859017f3c9920dc69bd2e25c8df8e7e773a5247414f613c
chaincode is installed on peer0.org2
Using organization 1
peer lifecycle chaincode queryinstalled
res=0
Installed chaincodes on peer:
Package ID: basic_1.0:4b4ef2874954eebf859017f3c9920dc69bd2e25c8df8e7e773a5247414f613c, Label: basic_1.0
Query installed successful on peer0.org1 on channel
Using organization 1
peer lifecycle chaincode approveformyorg -o localhost:7050 --ordererTLSHostnameOverride orderer.example.com --tls --cafile /home/ubuntu/go/src/github.com/igokuly2k/fabric-samples/test-network/organizations/ordererOrganizations/example.com/tlsca/tlsca.example.com-cert.pem --channelID mychannel --name basic --version 1.0 --package-id basic_1.0:4b4ef2874954eebf859017f3c9920dc69bd2e25c8df8e7e773a5247414f613c --sequence 1
res=0
2022-05-19 11:46:31.845 UTC 0001 INFO [chaincodeCmd] ClientWait -> txid [6ffa8ffb46763365fa838e3da1a361952b111e01e94c910df2d53955df3fb091] committed with status (VALID) at localhost:7051
chaincode definition approved on peer0.org1 on channel 'mychannel'
Using organization 1
checking the commit readiness of the chaincode definition on peer0.org1 on channel 'mychannel'...
attempting to check the commit readiness of the chaincode definition on peer0.org1, Retry after 3 seconds.
peer lifecycle chaincode checkcommitreadiness --channelID mychannel --name basic --version 1.0 --sequence 1 --output json
res=0
{
  "approvals": {
    "Org1MSP": true,
    "Org2MSP": false
  }
}
checking the commit readiness of the chaincode definition successful on peer0.org1 on channel 'mychannel'
Using organization 2
checking the commit readiness of the chaincode definition on peer0.org2 on channel 'mychannel'...
attempting to check the commit readiness of the chaincode definition on peer0.org2, Retry after 3 seconds.
peer lifecycle chaincode checkcommitreadiness --channelID mychannel --name basic --version 1.0 --sequence 1 --output json
```

**Figure 7. Chain code installed on peers of organizations**

# Screenshots



```
ubuntu@ip-172-31-42-249: ~/go/src/github.com/igokuly2k/fabric-samples/asset-transfer-basic/application-gateway-typescript
ubuntu@ip-172-31-42-249:~/go/src/github.com/igokuly2k/fabric-samples/test-network$ cd ../asset-transfer-basic/application-gateway-typescript
ubuntu@ip-172-31-42-249:~/go/src/github.com/igokuly2k/fabric-samples/asset-transfer-basic/application-gateway-typescript$ sudo iptables -t nat -A PREROUTING -i eth0 -p tcp
--dport 80 -j REDIRECT --to-port 8080
ubuntu@ip-172-31-42-249:~/go/src/github.com/igokuly2k/fabric-samples/asset-transfer-basic/application-gateway-typescript$ npm run serve

> asset-transfer-basic@1.0.0 serve
> nodemon src/index.ts

[nodemon] 2.0.16
[nodemon] to restart at any time, enter `rs`
[nodemon] watching path(s): *.*
[nodemon] watching extensions: ts,json
[nodemon] starting `ts-node src/index.ts`
channelName: mychannel
chaincodeName: basic
mspId: Org1MSP
cryptoPath: /home/ubuntu/go/src/github.com/igokuly2k/fabric-samples/test-network/organizations/peerOrganizations/org1.example.com
keyDirectoryPath: /home/ubuntu/go/src/github.com/igokuly2k/fabric-samples/test-network/organizations/peerOrganizations/org1.example.com/users/User1@org1.example.com/msp/ke
ystore
certPath: /home/ubuntu/go/src/github.com/igokuly2k/fabric-samples/test-network/organizations/peerOrganizations/org1.example.com/users/User1@org1.example.com/msp/si
gncerts/cert.pem
tlsCertPath: /home/ubuntu/go/src/github.com/igokuly2k/fabric-samples/test-network/organizations/peerOrganizations/org1.example.com/peers/peer0.org1.example.com/tls/ca
.crt
peerEndpoint: localhost:7051
peerHostAlias: peer0.org1.example.com
channelName: mychannel
chaincodeName: basic
mspId: Org1MSP
cryptoPath: /home/ubuntu/go/src/github.com/igokuly2k/fabric-samples/test-network/organizations/peerOrganizations/org1.example.com
keyDirectoryPath: /home/ubuntu/go/src/github.com/igokuly2k/fabric-samples/test-network/organizations/peerOrganizations/org1.example.com/users/User1@org1.example.com/msp/ke
ystore
certPath: /home/ubuntu/go/src/github.com/igokuly2k/fabric-samples/test-network/organizations/peerOrganizations/org1.example.com/users/User1@org1.example.com/msp/si
gncerts/cert.pem
tlsCertPath: /home/ubuntu/go/src/github.com/igokuly2k/fabric-samples/test-network/organizations/peerOrganizations/org1.example.com/peers/peer0.org1.example.com/tls/ca
.crt
peerEndpoint: localhost:7051
peerHostAlias: peer0.org1.example.com
Contract returned successfully
Contract returned successfully
```

**Figure 7. Running Application Gateway**

# Screenshots



**Figure 8. Modes to select for IoT device connected**

# Screenshots



The screenshot displays a mobile application interface for 'PDS Supply Chain Tracking'. The screen is titled 'PDS Supply Chain Tracking' and is in 'Create Asset Mode'. It features two input fields: 'Type' and 'Size', each with a blue border. Below these fields is a grey 'Submit' button. The interface is presented on a black smartphone frame with a home button at the bottom.

**Figure 9. Create Asset Form**

# Conclusion

1. Proof of Concept on functionalities of PDS using Hyperledger Fabric makes us to confirm that Permissioned Blockchain Infrastructures are helpful in inducing more transparency, traceability and accountability in food logistics and supply chain industry.
2. Blockchain would fortify trust among organizations involved in the chain and consumers would be aware of the product and its lifecycle.
3. This prototype can be made possible into a real time project by using Far Range UHF Passive RFID technology. Tags are inexpensive and RFID reader's proximity can range up to 12 meters.
4. Validation and authentication must be focused more in upcoming steps.

# References

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- [2] Melanie Swan,"Blockchain Blueprint for a New Economy",Published by O'Reilly Media, Inc.,2015
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- [4] Reshma Kamath,"Food Traceability on Blockchain: Walmart's Pork and Mango Pilots with IBM", The JBBA,2018
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# Plagiarism Report