

Tracking Industrial Assets using Blockchain

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Abstract

This paper presents the implementation of Blockchain technology for tracking the movement of assets/equipment within the organization effectively and to share the asset/equipment without any formal authorizations. There are several methods to track the movement of goods using different custom developed software applications. In this work, software application is developed taking Blockchain as its back bone. HTML, CSS, Java script are used to develop the User interface of this application. Python is used to build the server program. SMS service Twilio has been used in this application to send the OTP. Usage of Blockchain Technology for this application makes it superior than the other applications in terms of data security and immutability of data. Asset transfer can be made transparent or private to all the users in the chain subject to the application. Once after the submission of the data it can never be overridden or countermanded.

Keywords: *Blockchain, Docker, Ec2, Equip-chain, Multichain, MQTT*

1. Introduction

Tracking the assets is to know the whereabouts of the assets or tools being used in the industry, traditionally this was done by maintaining a paper ledger which includes the details like name of the tool, issuer and receiver names. The asset sharing process between the organization and the employee involves a hectic process of employee requesting for permissions to access that asset, and usually it takes time as the one who authorizes it might not be available all the time. Later, the technology advancement replaced the paper ledger process with a Digital Ledger. Programming languages and concepts were used to develop these Digital ledgers.

Even these Digital solutions comes with the problem where people who are responsible to monitor and update the assets/tools movement in the Databases can overwrite the details of the goods at any point of time, means they can manipulate a particular transaction detail. This is where Blockchain [1] can play a crucial role, as by design it is well known for its immutability of data, and the consensus [2] mechanism in blockchain enables people in the chain to have their own copy of data. Blockchain doesn't have the concept of having

central authority to approve the transactions, this feature enables us to avoid the request permission process to access the asset.

Blockchain is a Decentralized ledger, distributed across the nodes to store the sequence of the Transactions between the parties in the chain. A Transaction can be, sending Money to person/company from one another, or Exchange Process of Goods in return for either currency or other goods. A computer that runs the software related to blockchain is often called as a node in this process. Every individual willing to participate in the chain to do some transactions with other participants within the chain, should have a computer that runs the blockchain software.

All these transactions are cryptographically approved by the parties involved in the chain. No one in the Chain can modify these transactions once after they were committed. Because Present Transaction is linked to its previous transaction and that will be linked to its predecessor, and that's how they form **chain of Blocks** where each block holds the transaction related data, the digital fingerprint of the node who approved that transaction, and the previous transaction's hash [3] value. If we try to modify one block, we must start

modifying all the blocks from then in the sequence. Even if we dare to do that, we need a lot of super computer power.

A Trading Company/person from Japan called “*Satoshi Nakamoto*” implemented and started using Blockchain technology to implement the first cryptocurrency called Bitcoin. There are two types of Blockchains. First one is called Public Chain, where anyone in the chain can approve your transaction and we won't have any control over the people in the chain. Bitcoin, Ethereum are the examples for Public Blockchains. Second one is called Private chain, where a limited number of people in the chain will have control over the network, and those can decide who can participate in the chain and who can send, receive a transaction. We can also decide who can be our Transaction approvers called miners.

Multichain [4] is one of the Blockchain platforms, it is a private and permissioned Blockchain. We can start running our own blockchain network in our Environment with minimal effort, barely just two simple steps to create a new blockchain, and three to connect to an existing one. We can have control(optional) over the participants in the chain who can connect, send and receive transactions, who can create assets (any tangible and intangible things). We can issue millions of assets, and we can perform multi-asset and multi-party atomic-exchange transactions. Multichain uses Round Robin Scheduling Algorithm to do the mining process.

Blockchain is one of the most happening things in the present fast-growing world, even though it became popular with the Bitcoin, eventually people started realizing the potential of the Blockchain in the other industries like Health care, Food supply chains, Internet of things, Financial sector etc. We needed Blockchain to bring trust between the untrusted entities. Paper published by Zibin Zheng in 2017 [5] gives us the overview and future trends of the blockchain. Feng Tian [6] published on how blockchain can be used to revolutionize the Agri-food supply chain Traceability, this method uses RFID Technology and Blockchain

together where they connect farmers, warehouse people and the retailer to the same chain to keep the details of these entities transparent to one another. This can bring the change in tracking the quality and safety of the agri-food. The paper on Blockchain in Logistics and supply chain [7] by Mr. Guido Perboli, Stefano Musso, Mariangela Rosano emphasizes the possibilities of using Blockchain in the supply chain industry. Let the supply can be related to agri-food or tracking a goods shipment or tracking the journey of a diamond from the rocks to the diamond store.

The following table shows what has been considered as the organization, sample assets and people involved in the blockchain of this application.

s.no	Role	Example
1	Blockchain Platform	Multichain
2	Organization	Technical Department (Engineering College)
3	Assets	Arduino, Raspberry pi, Sensors
4	Admin (Participants)	Technical Department
5	User (Participants)	Employees, and Students

Table 1: Application specific Details

The primary objective of this paper is to show the implementation of blockchain based solution to track the industrial assets, and to prove how can blockchain bring trust in the asset exchange process in an organization. The paper is well ordered as follows. The Section II discusses the overview of the application. Section III gives application architecture. Section IV explains the working of this application. In section V we discuss the Example Scenario of this application. Finally, this paper concludes with a summary described in Section VI

2. Overview

This application is named as the Equip-chain. The idea of this equip-chain is to trace the movement of the assets that are being used in the organization without any authorization process to request permissions to access the asset. Equip-chain installed organization allows

the employees to join in the chain. After the registration, the employee will be given access to the web application where he can check the assets that are available in the organization and the assets that are with him, and to perform send and receive asset, operations. The organization itself and each employee will act as a node in the chain usually called as admin and user nodes respectively. The admin node will create the assets that are available in the organization. Employee requests the admin for an asset of his choice when he is in need. From then the asset journey in the chain will start, the user can give back the asset to the admin or he can pass the asset to another employee who is in the equip-chain using the web application. Admin can track the asset at any given time and he can know the journey of an asset from the time it was created in the chain to till date within the company.

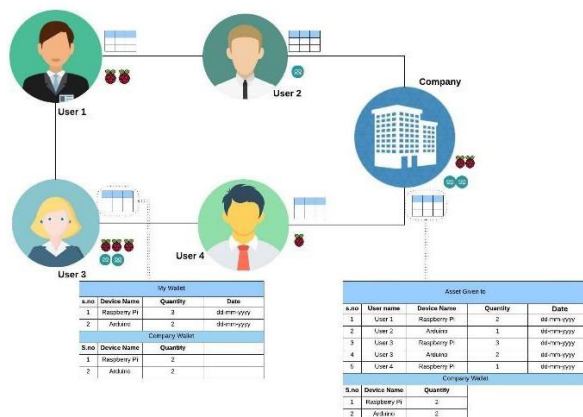


Fig 1: Block diagram

The above diagram illustrates the equip-chain application concept, as we can see the employees and the company are connected. I have taken Raspberry pi [8] and Arduino [9] as the sample assets that were created by the organization as its assets. we can see at this point of time the admin wallet has the details of assets that are with others and assets that are with itself. And the employee (user 3) wallet has the details of assets with him/her and assets with the company.

3. Equip-chain Architecture

To run this application, first we must have the nodes those have blockchain setup installed and running. The application used the docker containers [10] to act as a node. These Docker containers are running in Amazon EC2, The EC2 instance will act as the admin node and the individual docker containers in the EC2 instance acts as the nodes for the employees and students. By doing this we can make sure each employee will have a node to participate in the chain, and we can avoid having practical problems like having a computer dedicated to run this application, and even maintenance of the node will become easy.

The Equip-chain mentioned in this paper contains 2 software programs, those are User Interface and Application Server.

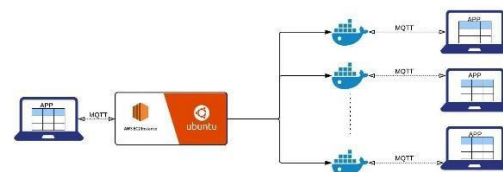


Fig. 2: Architecture overview

3.1 User interface

The software application developed using HTML, CSS, JavaScript enables the user to interact with the equip-chain application server program. This is just to make the application user friendly for operational purpose.

Equip-chain

USER NAME

PASSWORD

LOG IN

Fig. 3: Login page

Dashboard RequestEquipment

ASSET GIVEN by T-HUB

Asset Name	Asset With(current)	Quantity	On(Idle)
Update			

ASSET LEFT at T-HUB

Asset Name	Quantity Left

Fig. 4: Dashboard page

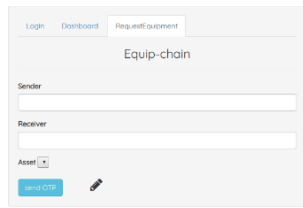


Fig. 5: Equipment request page

3.2 Application Server

This application server developed using Python, where we have functions defined to interact with the Multichain using Python SDK to connect/send/receive/check asset balances. The following diagram shows the modules that were installed in each node.

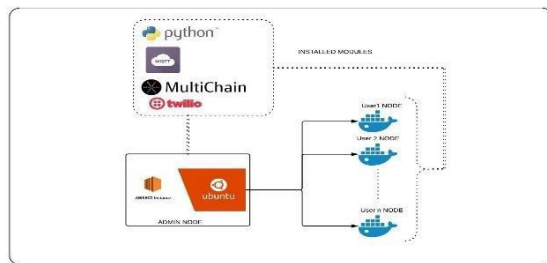


Fig.6: Modules installed in Ec2 and container

Let's go through the details of the Technologies have been used in this application

3.2.1 AWS EC2

Amazon web services (AWS) is a secure cloud services platform, offering computer power, database storage, serverless computing, Mobility and other functionalities those can help you to build your own business requirements at one place. Amazon Elastic Compute Cloud (EC2) is computing service in AWS. Instead of having in-house hardware setup for servers to host your applications of your business requirements, we can depend on AWS EC2 which is readily available and easy to develop and deploy. The maintenance of your application will be taken care by AWS. Depends on the Traffic to our application we can scale up or down when we want to do so.

3.2.2 Docker

From Wikipedia, Docker is defined as a "computer program that performs operating-system-level virtualization also known as containerization". Docker is used to run software packages called "containers".

Containers are isolated from each other and bundle their own tools and Libraries. These containers run by a single operating system kernel. Containers are created by source called images. Images can be created from an operating system (Linux/windows) with some other libraries or tools of our choice.

3.2.3 MQTT

Message Queuing Telemetry Transport [11] is machine-to-machine Internet of Things connectivity protocol. It was designed as an extremely lightweight publish/subscribe messaging transport between two entities. This has been used in the application as communication medium between the user interface and the server application in real time.

3.2.4 Twilio

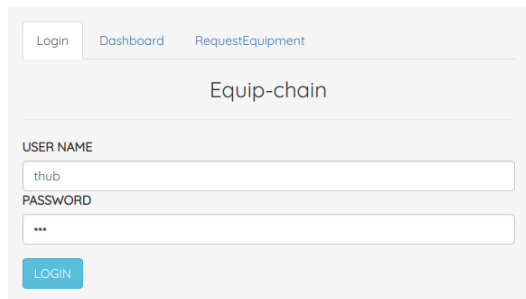
[12] A cloud platform for SMS, voice & messaging application using the API's (PHP, .NET, Java, Node.js, Ruby, Python) developed by them.

4. Working Methodology

Once after the installations and registrations have been done, we are ready to start using this application. Admin node will start creating the assets like Arduino and RPI, that are available in the organization. Any employee/student who wants one of these assets will have to approach the person who holds that asset currently, initially it will be the admin. The issuer will log into the web application and will start the asset sending process. As part of the transaction the employee will receive an OTP (One Time Password) to his mobile phone, only if the receiver shares the OTP to the sender then only the asset transfer will be successful. By doing this we can assure the confirmation from the receiver. Now both the issuer and the receiver (employee) can check their asset balances by just checking their respective web application's *Dashboard* tab. Like this people in an organization can send and receive the assets securely without any authorization involved. Blockchain's decentralization and immutability of data assures the security of this application.

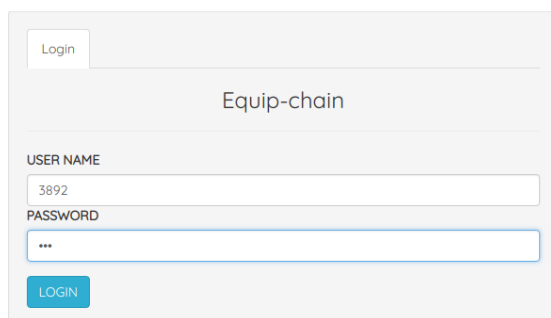
5. Example Scenario

These are the images that shows the example asset sending process scenario. The User interface we can open in the web browsers and the Application server programs are being ran in the ec2 instance and the docker container.



The Admin Login interface shows a 'Login' tab selected. The form includes fields for 'USER NAME' (containing 'thub') and 'PASSWORD' (masked with '***'). A 'LOGIN' button is at the bottom.

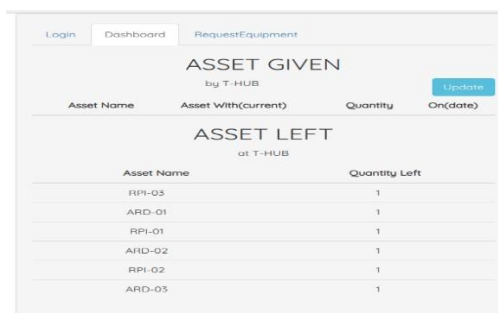
Fig. 7: Admin Login



The User Login interface shows a 'Login' tab selected. The form includes fields for 'USER NAME' (containing '3892') and 'PASSWORD' (masked with '***'). A 'LOGIN' button is at the bottom.

Fig. 8: User Login

Step 1: Figure 7 and 8 shows the login process for both Admin and the User of this application.



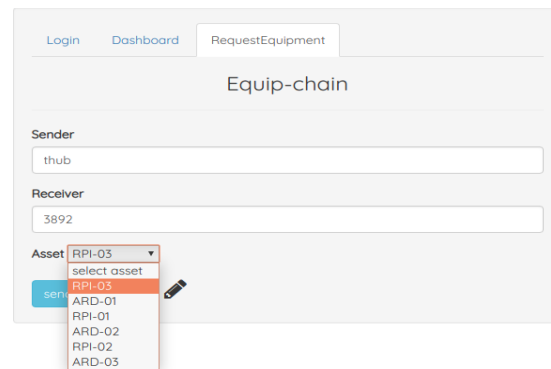
The interface shows 'ASSET GIVEN by T-HUB' and 'ASSET LEFT at T-HUB' tables. The 'ASSET GIVEN' table has columns: Asset Name, Asset With(current), Quantity, and On(date). The 'ASSET LEFT' table has columns: Asset Name and Quantity Left.

Asset Name	Asset With(current)	Quantity	On(date)
RPI-03		1	
ARD-01		1	
RPI-01		1	
ARD-02		1	
RPI-02		1	
ARD-03		1	

Asset Name	Quantity Left
RPI-03	1
ARD-01	1
RPI-01	1
ARD-02	1
RPI-02	1
ARD-03	1

Fig. 9: Asset updated balances

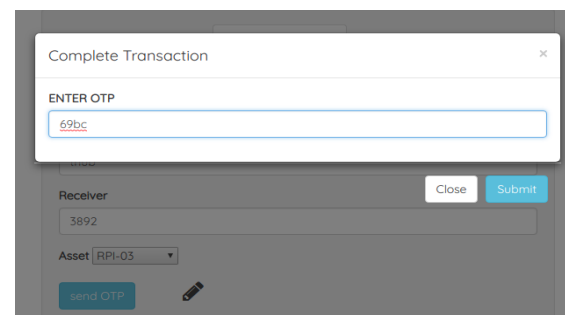
Step 2: Figure 9 shows the Assets that are with the organization. we can see the asset details under the Dashboard tab of this application. We can see the organization have assets RPI-01, RPI-02, RPI-03, ARD-01, ARD-02, ARD-03 each quantity as one.



The interface shows the 'RequestEquipment' tab. It includes fields for 'Sender' (containing 'thub') and 'Receiver' (containing '3892'). An 'Asset' dropdown menu is open, showing options: 'select asset', 'RPI-03', 'ARD-01', 'RPI-01', 'ARD-02', 'RPI-02', and 'ARD-03'. A 'send OTP' button is visible.

Fig. 10: Asset transfer process

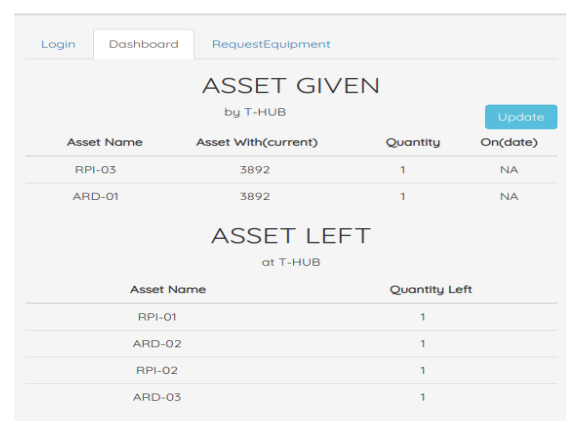
Step 3: Figure 10 shows the Asset transfer procedure, we can select one of these assets that are available in the organization and names of the sender and receiver in the respective fields. Then we can start initiating the transfer process by clicking on the “send OTP” button. The OTP will be sent to the user from the application server program.



The interface shows a 'Complete Transaction' dialog box. It includes a field for 'ENTER OTP' (containing '69bc'). Below the dialog, the 'Receiver' field contains '3892' and the 'Asset' dropdown is set to 'RPI-03'. A 'send OTP' button is visible.

Fig.11: Completing OTP

Step 4: Figure 11 shows the completing of the transaction by entering the OTP that received by the user. Once after the OTP verification process that transaction will be completed.



The interface shows 'ASSET GIVEN by T-HUB' and 'ASSET LEFT at T-HUB' tables. The 'ASSET GIVEN' table has columns: Asset Name, Asset With(current), Quantity, and On(date). The 'ASSET LEFT' table has columns: Asset Name and Quantity Left.

Asset Name	Asset With(current)	Quantity	On(date)
RPI-03	3892	1	NA
ARD-01	3892	1	NA

Asset Name	Quantity Left
RPI-01	1
ARD-02	1
RPI-02	1
ARD-03	1

Fig. 12: Updated Asset Balances in Admin application

ASSET IN MY WALLET	
by T-HUB	
Asset Name	Quantity Left
RPI-03	1
ARD-01	1

Fig. 13: Updated Asset Balances in User application

Figure 12 and 13 shows the updated asset balances in both admin and the user applications. In the above example scenario, I have sent two assets namely *RPI-03* and *ARD-01* to user 3892.

6. Conclusion

This paper presented the possibilities of using Blockchain to track the movement of the Assets being used in the Organizations. This paper showed the feasibility of the Multichain based Blockchain solution with the minimal effort and the minimal cost and maintenance using Amazon Ec2, and Docker containers effectively to act as nodes. Equip-chain's ease of access made it very simple to use, even a person who is not a technical buff can use it. The application mentioned in this paper being implemented and tested in Aditya Engineering College and can be used in a place where the tracking of the assets from time to time is very crucial.

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