A Synopsis on

Blockchain Based Web Framework for Pharma Supply Chain

Submitted in partial fulfillment of the requirements of the degree of

Bachelor of Engineering

in

Information Technology

by

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CERTIFICATE

This is to certify that the project Synopsis entitled ***"Blockchain Based Web Framework for Pharma Supply Chain"*** Submitted by ***"Jainam Chopra(18104064)", "Yash Bhosale(18104049)", "Satish Gupta(18104024)"*** for the partial fulfillment of the requirement for award of a degree ***Bachelor of Engineering*** in ***Branch Name.***to the University of Mum- bai,is a bonafide work carried out during academic year 2019-2020

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Abstract

The current COVID-19 pandemic impacted globally and resulted one hundred million cases with almost two and half million death to-date. The concerns of further spread of the virus has caused the global economy to a halt when most countries globally implementing movement control. Recent approved vaccines developed by multiple fronts has shed some hoped for the recovery of the human activities back to pre-pandemic state. For Malaysia, the government has procured the vaccine from six suppliers and each vaccine require proper temperature monitoring to ensure the safety and the efficacy of the vaccines during transportation and distribution process. Effective vaccine Cold Chain Logistics (CCL) management will be required precise coordination and cooperation across multiple parties to ensure the quality of the vaccines which require temperature monitoring, distribution of records for traceability. Furthermore, the CCL process continuity is becoming critical from the handover point at Malaysia point of receipt from the manufacturer and further distribution from central storage to the two hundred vaccination center across the country. Key concerns will be the vaccines' CCL process for remote areas in Malaysia. This paper will describe the architecture required to integrate IoT and Blockchain into the CCL management system to monitor the temperature of insulated container or cooler box. In this study, it shows that promising system of integrating IoT and Blockchain for COVID-19 vaccine CCL management.

Introduction

In general, cold-chain is defined as the process used to maintain optimal conditions during the transport, storage, and handling of cold chain products, from the point of manufacturer to the point of use [1]. Referring to [2], cold chain is defined as maintaining the fresh food and frozen foods such as the quality of the products from the initial process. Cold Chain Logistics (CCL) management, in general, is the management of necessary refrigeration level for temperature sensitive product. The scope of the CCL including agricultural products, processed foods and special products (such as drugs and vaccine). CCL consisting of low-temperature processing, low-temperature transport and distribution, low temperature storage and low-temperature for aspects of marketing [2]. Using ISM, analysis of cold chain development has been investigated in [3] and analysis of risk factor of medical CCL has been investigated in [4]. Several studies have investigated the application of wireless sensor network and Internet of Things (IoT) in CCL [5-8] while others investigated the data security issues that arose in CCL [2,9-10]. One of the most critical issues, currently not fully managed in CCL, is the safe transportation of temperature sensitive medicines, vaccines, and biological samples. The diffusion of emerging technologies enabling the Internet of Things such as embedded systems, mobile Apps and Cloud services, it is possible to obtain continuous monitoring of sensitive substances and environments. Previous work by [11] proposed a system called SensIC for monitoring the refrigerated storage of drugs, vaccines, medical devices and any biological samples (blood and its derivatives, saliva, urine, cells of various types and classification). The proposed system offers immediate alarm tools in case of malfunction of the refrigeration systems (fridge and/or freezers) using implementation of smart device called SensBox and a cloud infrastructure dedicated to device management. Previous study by [12] proposed a Blockchain solution for secure IoT data acquisition used for weather monitoring. In their study, a system consisting of ESP8266 microchip and temperature and pressure sensor of GY-BMP280 has been developed. The data collected from the system displayed on the web interface of Grafana to thoroughly view over the weather. Data collected then sent to Raspberry Pi gateway for further processed and will make up for the transactions inside the chain. Vaccine management and monitoring, cold chain management, and immunization safety are the key areas of logistics support. Logistics ensures that vaccines are available at the right time, in the correct amount, and in the correct condition. The cold chain refers to the storage and transportation of vaccines at recommended temperatures from the manufacturing location to where they will be used. An effective cold chain ensures that vaccines will remain effective and usable when they are administered [13]. It has been established that any breach in temperature control can degrade a vaccine, making it lose its full potency. An unbroken cold chain with temperatures below the required storage temperature has to be maintained, or it will risk defrosting and losing its efficacy within a day of temperature breach above the required storage temperature. Hence, a good temperature monitoring and control is required throughout the transport process to ensure vaccine quality and safety. IoT is an encouraging model that integrates several communication and technical solutions. The IoT is defined as a field in which each physical object is to be connected at any time and at any place with the help of internet and to be able in identifying these devices to other devices [14]. The objective of this project is to setup a temperature monitoring prototype based on IoT & Blockchain system to collect store critical data, such as temperature breach, for COVID-19 vaccine CCL. The IoT system to continuously monitor the inside of an insulated container or cooler box to ensure the integrity of the vaccine storage during transport and transit to the remote vaccination centers. The introduction of the IoT system in the CCL will enable ‘in-situ’ temperature while in transit. The data collected will assist the CCL process managers to track and trace the process. The integrity of the data collected will be protected by the Blockchain system established.

Objectives

- To make the process transparent and free from human errors, which traditionally were present in the existing infrastructure.
- To get a near real time update of the whereabouts of a shipment.
- To create trust between new parties due to the use of immutable transactions present in the blockchain, which proves the trustworthiness.
- To build a simple user interface for a common customer to use it.
- To design a supply chain traceability system that models manufacturing processes as token recipes.
- To present a prototypical implementation for the Ethereum Virtual Machine (EVM) using smart contracts.
- To make users or the members present in a blockchain aware about the whereabouts' and the conditions of vaccines, medicine's etc.
- To provide a decentralized, immutable, and secure blockchain.

Problem Definition

Existing COVID-19 vaccine supply chain processes are fragmented, making it difficult to capture and collate the data generated at every touchpoint while ensuring product authenticity and continuity of cold chain. Without aggregated data, it becomes difficult to get visibility into assets and conditions throughout the value chain, leading to the following challenges:

- Maintaining process and transaction transparency across all parties
- Ensuring product authenticity and secure transfer of vaccines without breaking cold chain
- Tracking secure box in real time for temperature control and ownership
- No real-time data availability for decision making
- Lack of a seamless process for controlled vaccine delivery
- No process for dispute settlement in case of violation

Proposed System Architecture/Working

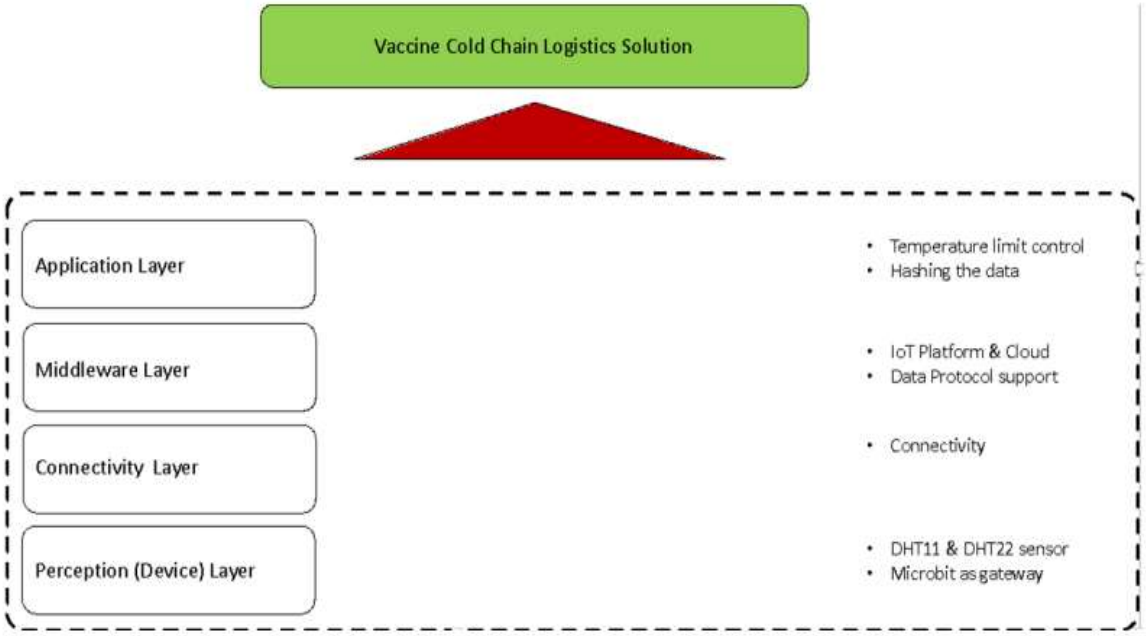

Fig: Monitoring System based on Blockchain

2.1. Device Layer :The objective of the device layer is to collect the temperature data within cooler box (insulated container). The temperature sensor for this project prototype will utilising DHT-11 sensors and this sensor has been chosen mainly due to the consideration of its characteristics.
The sensors connected to the Micro:bit board for data processing as the signal generated is in electrical pulse to be translated by Micro:bit based on the driver program, obtained from the manufacturer, combined into the 'coldbox.py' program written inside the board. The 'colbox.py' program is a set C codes and command to measure the temperature inside the cooler box every 5 minutes; to translate the electrical signal to temperature; and to push the data to the IoT Platform in the Middleware. The data obtained is then wrapped in mosquito (MQTT) data exchange protocol, which was then tagged with JSON service discovery protocol for northbound communication to the IoT Platform

2.2. Communication Layer :The wrapped data from the device layer is then transported through the communication layer via 4G using TCP/IP. For security purpose, a pre-set API key and Channel ID was assigned to the system. This information is embedded into the 'coldbox.py' program together with authentication details to sign on process to the IoT Platform.

2.3. Middleware Layer :The middleware is the service management layer for the IoT system as it is the layer that process received data, make decision delivers required services. In general middleware functions are for Service Discovery; Data Exchange; and Data Processing. For this project, the system is connected to 'ThingSpeaks' (www.thingspeak.com) as the middleware for service discovery and dashboard and storage. The collected data are stored in database setup in ThingSpeak (Matlab) cloud. Previous work by [15] proposed a system for monitoring heart rate and temperature data with the application of IoT using the similar system propose in this study.

2.4. Application Layer :The application is defined as the layer to process the data. In this layer, the ‘business logic’ where the temperature breaches are calculated. For the purpose, the project utilised the embedded features of Matlab. The code will check for the temperature breach and send in the email to the admin of the CCL process. At this layer also where the data will be to create the blockchain for data integrity. Duly noted that the IoT system is resource constraint. Hence, the project must choose the most suitable platform for the project. Each platform tabulated as in Table 2 referring to previous research [16]. Previous research by [17] investigated a model with IOTA/Tangle network which received data from wireless multi-sensor device, Bosch XDK110. Motivated from study by [17], for this project, IOTA was selected as the Blockchain platform. This is due to the fact it is much easier to setup and scalable with the increase of the size of the network if compare to the other platform. Furthermore, the IOTA offers a hashing option between SHA3 and SHA256. With a lighter option, it will reduce the needs for higher processing at the IoT system.

Design and Implementation

IoT sensors/devices capture data automatically, without human intervention. It helps determine and verify the source of component materials and their regulatory compliance. Sensors embedded in transported goods can monitor items and alert supply chain members to issues such as temperature deviations or product damage. At every stage of the supply chain data is captured with sufficient granularity to conduct root-cause analyses, determine liability in case of an incident, and gain any number or type of insight. When IoT data feeds into a blockchain, the data can be shared within a peer- to-peer network, distributed ledger. Each member of a supply chain—including producers, suppliers, processors, distributors, and retailers—is a node in the blockchain network and can access all data within the blockchain at any time. Smart contracts— self-executing scripts residing within the blockchain—integrate members and allow for proper, distributed, heavily automated workflows for information sharing. This provides a fully transparent, single source of truth about the provenance of materials, production history, and condition of items in transit changes of custody and ownership, and last-mile delivery information— all in real time.

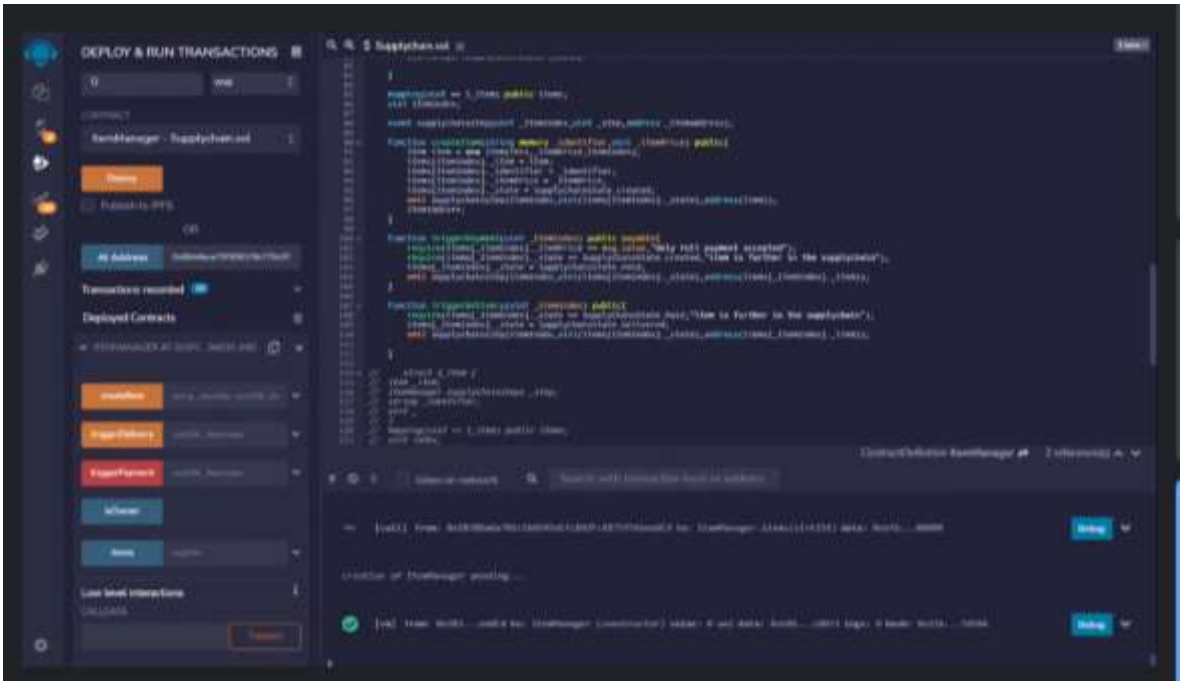

Fig 2: Blockchain Backend for order processing

Fig 2: Frontend Web Framework

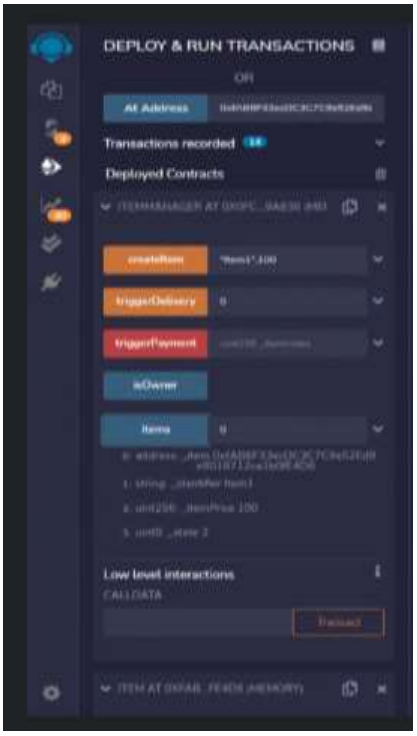

Fig 3: Buyer side backend

Summary

This project has presented a way to integrate IoT and Blockchain system to continuously monitor temperature for vaccine CCL processes. The project took the liberty to conduct an experiment to understand the effect of external temperature to the inside temperature of the cooler box to demonstrate the utility of the data gathered for the CCL process manager to design the insulation of the storage container CCL. The project also demonstrated on the method to protect the data integrity of the CCL process. For future work, research to consider the inclusion of controlling temperature of the container by turning on the refrigeration unit once the temperature to be 10% form the limit and the transit time to limit before it reached the maximum allowable storage temperature using the data acquired from IoT system

References

[1] People's Republic of China National standard terminology logistics [J], China storage and Transportation 2001, (3):40-43.

[2] Gao Xuling, et al. E-commerce environment of cold-chain logistics study [J]. Logistics Technology,2006, (4):11-13.

[3] Fang Xin. [J]. Logistics Technology and Application, 2004, (11):56-60.

[4] Li Zhijun. Watch the cold chain from the food safety technology [N]. Modern logistics is reported in 2007. [5] Chinese cold chain logistics in 2008 research report [R].2008.

[6]Tang Xiaofang. HACCP food safety management system set up and implementation [M]. Beijing: China Metrology Press, 2003: 130-133.

[7] Qiu Zhuqiang, Xie Ruhe, Gui Shouping. Perishable agricultural products logistics security control mechanism [J] .2008, (9):23-25.

[8] Xi Xiangde. Fragile cold chain [J].Global Entrepreneur. http://www.gemag.com.cn/gemag/new/ 2007,12(146).

[9] Jin Tao. High standards for the operation of cold milk Raiders logistics [J]. Logistics Technology and Application, 2008, (8) :62-64.

[10]Yao Xiaohui, Wang Shan, Wang Tong. Road transport of dangerous chemicals and the cause of the accident frequency study [J]. Safety, 2005, (5): 37-38.

[11]Bao Changsheng. Cold-chain logistics system, system of food safety protection [J]. Modern management science, 2007, (9):66-67.

[12]Jim Thompson. Strength Weak Links in the Cold Chain Asia-Pacific Refrigerated Trade 98 Conferences.1998,(3):4-6.