THE UNIVERSITY OF SYDNEY

School of Information Technologies
Faculty of Engineering & IT

ASSIGNMENT/PROJECT COVERSHEET - GROUP ASSESSMENT

Unit of Study: COMP5703 IT Capstone Project

Assignment name: Project Proposal

Tutorial time: Wednesday 16.00-18.00 **Tutor name:** Hamid Samani

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A Reference Model of Applying IoT (Internet of Things) and Blockchain to Enterprise System

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Abstract

This proposal explains the detailed information of how we will process the project, in which the IoT technologies, such as the blockchain, are to apply to achieve the objective of eradicating counterfeit pharmaceuticals. A comprehensive introduction of this project will be illustrated in this proposal. In order to fulfill our goals, we will develop a new system with the assistance of blockchain database, BigChainDB, to realize the authenticity and uniqueness of the legal pharmaceutical. In the system, each legal pharmaceutical will be granted a unique code, which is stored in the BigChainDB, as well as all its transaction information. This means when the same code is transactioned more than once, the transaction will be declined as its transaction record has been in the BigChainDB system. Also, to enable the users to track the information of each pharmaceutical, we will apply the react-redux, react-native to develop a web app and mobile app respectively to enrich the system.

Keyword: Counterfeit drug, IoT, blockchain, BigchainDB, React, Flux, Redux, React Native

Literature Review

1 Background Analysis

As a result of economic globalization, people can buy any products from other countries on the internet. However, more and more counterfeit products flow into the market, among these counterfeit goods problems (Sowder, 2016)., fake medicine deserves be paid more attention by public. Counterfeit medicine is a global problem. Due to this problem, the mortality rate is very high in any country around world per year especially in some undeveloped countries. The World Health Organization estimates that approximate 10% of the global pharmaceutical market is counterfeit drugs (Nsimba, 2008). This percentage will up to 25% in some developing countries, even more in individual countries this percentage would increase to 50%(Nsimba, 2008). For example, in China, it is estimated that around 192,000 people died because of counterfeit drugs in 2001, and approximately one-third to one-fifth of antimalarial drugs are fake in southeast Asia (Cockburn et al., 2005).

The number of counterfeit pharmaceutical drugs is still growing at a significant rate. The US Food and Drug Administration (FDA) published the number of counterfeit drugs from 1997 to 2004 (Figure 1) (Nsimba, 2008). This chart shows that the counterfeit problem is a problem which cannot be ignored.

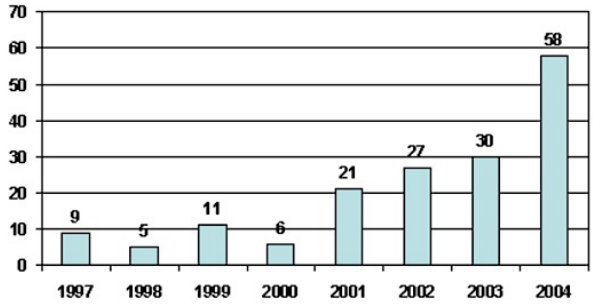

Figure1. The Counterfeit Drug Published by FDA

2 Existing Platform

To ensure that consumers can obtain good quality drugs, there are many existing technology methods to check the authenticity of drugs. The following paragraphs will detailed explain two existing verification means.

2.1 Mobile Authentication Service(MAS)

The National Agency for Food and Drug Administration and Control (NAFDAC) introduced this service to Nigeria to control the counterfeit medicines problem (Ayodokun, 2014).
The MAS has three steps to verify the medicines. Firstly, consumer scratches the sproxil label on the product package back, which contain the unique twelve digits PIN (Ayodokun, 2014). Secondly, consumer sends the PIN via SMS to a dedicated number which would automatically reply the information about the authenticity of the product (Ayodokun, 2014).

2.2 Rapid Alarm and Product Recall System

This is a drug tracking and recall system. If the consumer thinks they have bought a counterfeit drug, they can submit a description of the drug to the system, and then the consumer will receive an expert feedback (Isah, 2012). This system to the largest extend can ensure only the approved drugs can be traded on the market. Drugs which have side effects would receive a warning, and illegal drug will be recalled (Isah, 2012).

3 Why Block Chain?

There are amount of reasons lead to the counterfeit drugs problem that cannot be cured. The high profits is the main reason, the Centre for Medicines in the Public Interest announced that the counterfeit drug sales reached 35 billion US dollars in 2004(Nsimba, 2008).In addition, the lack of relevant legislation and the regulations for the current pharmaceutical market(Organization, 1999), and the supervisor by the national medicine regulatory authorities is poor and the regulation of the free trade area for exporting countries are absent would be another reason.(Organization, 1999). Therefore, it is difficult to distinguish which manufacturers and distributors are worth to trust.
Furthermore, there are two drug validation techniques that is analyzed above, which are not enough for this problem. The sproxil label in the MAS can be torn off and stick on the counterfeit drug package, and the rapid alarm and recall system can only be used to check and report the counterfeit drug, and the inaccurate description of the drug would lead to the misjudgment of the authenticity of the drug. Besides, the professionalism of experts is also needed to be questioned.
To solve the above problems and the technical concerns, the proposed system will use blockchain technology. Blockchain technology has been used in many areas and industries.
Blockchain can offer a great help to optimize of decentralized IoT platform. Because blockchain can guarantee the security and reliability of data exchange and record (Crosby et al., 2016). Therefore, blockchain can ensure that all the information is authentic and reliable during the information exchange between the IoT intelligent devices.
In addition, blockchain is a good solution to solve the distrust problem of supplier and distributors that is mentioned above. In the supply chain, manufacturers, distributors, markets and consumers are all involved in the block network, they can store information in the nodes, which can guarantee the authenticity of the product information to the largest extent (Crosby et al., 2016). For example, Everledger company use blockchain technology to make the diamond supply chain more transparent. The platform can track the entire supply chain of diamond, and each block record includes product features, historical records and ownership. All participants in the supply chain can access the information in the block at any time (Sadouskaya, 2017).
In summary, blockchain is a good technique to solve the counterfeit drugs supply chain problem, which can assurance that the drug is from a reliable source and would not be replaced by counterfeit drugs during the transaction to the largest extend.

Methodology

1 Blockchain system

1.1 Overview

Based on the discussion in last section, there are two main problems exist in today's supply chain system. The first one is that it is very difficult to know the product's supply chain from the moment of inception until it reaches the end consumer. The second one is that it is very difficult to judge if fake products are mixed into the supply chain. To solve these two problems, proposed system will use the blockchain system, BigchainDB, which is a scalable blockchain database: a big-data database with blockchain characteristics including decentralization, immutability and built-in support for creation & transfer of assets (McConaghy et al., 2016).

1.2 Transaction Tracking with Product ID

To make the product supply process traceable, the best way is to assign a unique ID to each product and track this ID within the supply chain. However, the tracking data is all maintained by the transport organization, it is really easy to be tampered by the organization itself. With BigchainDB, all of the organizations, including the manufacturer, supplier, and government, can join the system to track the product's flow. More importantly, BigchainDB are very tamper-resistant, the tamper can be detected (and rejected) because of extensive use of cryptographic signatures, hash chains, and Merkle trees (GmbH, 2017 May). No one in the system can tamper the recorded transaction in BigchainDB.

1.3 ID Reuse Problem Solution

Only tracking the ID is not enough. As shown in the existing platform, within the supply chain, if one person copies the product's ID and reuse that ID for many times, it is hard to be discovered. With BigchainDB, our system can solve this problem.
As shown in Figure 2, assume there is an unscrupulous seller in our system and this guy copies the product's ID. Then he sells the real product to customer A. Our system will push this transaction to BigchainDB, and the transaction will be recorded.

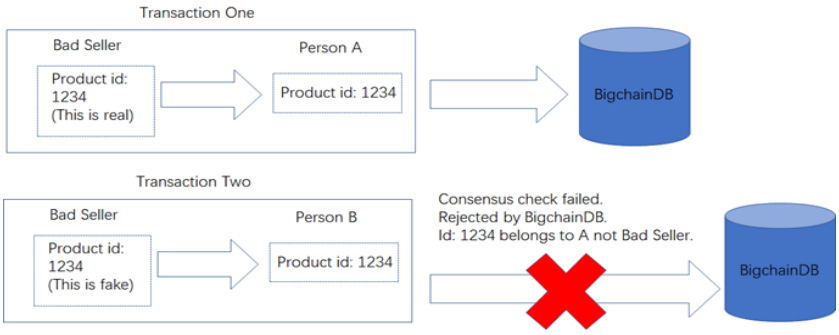

Figure2. Double-spending Check

After a while, the seller makes one fake product and tries to sell this product to customer B with the real product's ID. Our system will still push the transaction to BigchainDB. However, BigchainDB has the function called built-in transaction validity checking(GmbH, 2017 May). With this double-spending check, BigchainDB will find that the product with that ID belongs to customer A rather than the seller. In this situation, the transaction will be rejected by BigchainDB and customer B will recognize that the product is fake.

2 Other Technologies

2.1 React Library

React is a JavaScript library, which allows the code to be organized in a more predictable way (React, 2017). React will automatically manage and update the user interface (UI) when the data changes. React constructs reusable components, hence the components can be repeated used and every function can be encapsulated that would make the program easy to test and modify (React, 2017).

2.2 Web Application Framework

2.2.1 Flux Framework

To build a large web application, only have a UI framework is not enough. Therefore, Flux is a good option, which is a front-end framework that can organize the code and arrange the web application's internal logic (Flux, 2017). Flux can make the application easier to develop and maintain.

In the flux framework, the data is one-way flow, and Flux divide the application into four parts: view layer, store layer, dispatcher and actions.

The work flow of the Flux is show in Figure 3, if the view layer (react component) want to change any UI parts which will send a change action to the dispatcher, and the dispatcher will build a correct route for the change action. The store will save the status of the whole application. In the end, the view layer will receive a change event and then change the UI.

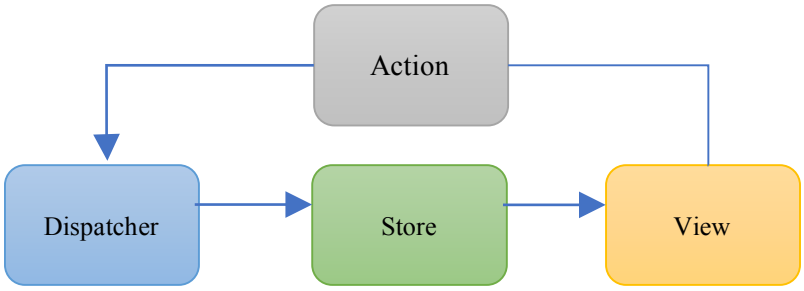

Figure 3. The Work Flow of Flux

2.2.2 Redux Framework

Redux is another front-end framework that combines Flux with functional programming. Redux is a predictable state container for JavaScript application, which is a great choice for complex web applications with multiple interactions and multiple data sources (Redux, 2017). In addition, Redux also can better manage and operate the states of application component. Redux can query, change the state and announce the state changes in the same place. Therefore, redux can better manage the application state in a simple way.

2.3 React-native

The mobile app is developed with react-native, a new framework that has several obvious advantages compared with the mainstream frameworks.

2.3.1 Community-driven.

The React Native is created by Facebook and supported and sustainably pushed forward by the development community which is composed with a large number of JS and native developers (React-Native, 2017). In this community, the corresponding developers share the components, expertise and the related knowledge with the users. This can ensure the rapid evolvement of this framework.

2.3.2 Code reuse and cost saving

With React Native, the code can be used both on iOS and Android, the leading two mobile app developing platforms (React-Native, 2017). Undoubtedly, this is an outstanding advantage of React Native to attract more companies and teams to adopt it since the reuse between iOS and Android means the time and financial contribution decline when developing a new product.

2.3.3 Live reload

Live reload is another interesting and attractive feature of React Native has (React-Native, 2017). With the advanced live reload concept, you can do something that you can only imagine in the native frameworks, that is, you can immediately see the change you make to your code. This means the efficiency of your work can be enhanced obviously as you can see what your change is rather than wait for the compile and other processes.

2.4 Node.js

The node.js is used to do the backend development in this project. This is because its distinct advantages compared with others.

2.4.1 Node.js is fast

Node.js runs on the Google's V8 engine, which means it can be compiled the JavaScript directly into machine code making it faster than most others (Chaniotis, Kyriakou, & Tselikas, 2015).

2.4.2 Dynamic NPM

Node.js is an open-source technology, which guarantees a leading edge with a shared repository of dynamic tools and modules. Meanwhile, the Node Package Manager (NPM) is on its way to reach the point to beat Ruby on Rails with more than 60000 modules (Node.js, 2017). Also, NPM is robust and speedy. This makes the dependency management perfect.

2.4.3 Easy on Coding

Another prominent superiority of Node.js is that it allows the developers to write JavaScript for both the server and client thus enabling the server and the client to coordinate the work simultaneously (Chaniotis et al., 2015). Benefited from this feature, the client can find the change on the data which is operated in the server and the web can show the updated data automatically.

User Stories

1 Definition of User Story

A user story is a natural language, informal expectation of one function of the software system written by the end user. In this proposed system, there are two main deliverables to the end users, the mobile application and web application. For the mobile application, there are some functions will only be used by specific types of users. These specific types of users are denoted as manufacturer, seller and buyer.

2 User Stories

<table>
<tr><th>Deliverables
Role in the system</th><th>Mobile Application</th><th>Web Application</th></tr>
<tr><td rowspan="4">User</td><td>(1) As a user, I can sign up an account or log in with existing account so that I can access to the mobile application.

(2) As a user, I can see if the transaction has succeeded.</td><td>(1) As a user, I can sign up new account or log in with existing account so that I can access to the web application with the browser.

(2) As a user, I can type in the product ID so that I can verify the authenticity and provenance or view the report of product's whole life story.</td></tr>
<tr><td>Manufacturer</td><td>As a manufacturer, I can generate new product ID.</td><td rowspan="3"></td></tr>
<tr><td>Seller</td><td>As a seller, I can scan the product ID so that I can start a new transaction.</td></tr>
<tr><td>Buyer</td><td>As a buyer, I can provide my account to the seller.</td></tr>
</table>

Timeline

To demonstrate the timeline and monitor the continuously progress status, a detailed timeline is constructed and the tasks have been defined and assigned to different students.

Week No	Task	Students in charge
Week 1	1. Determined objectives and goals of the project 2. Find out what should we learn 3. Learn something about react	Yuming Jiang Xinyi Liu Zhengyang Liu
Week 2	1. Learning redux concepts and models 2. Learn React-redux framework	Yuming Jiang Xinyi Liu Zhengyang Liu
	3. Background research on the existing system	Yuming Jiang
	4. Literature review on related fields	Xinyi Liu Zhengyang Liu
Week 3	1. Function designing	Yuming Jiang; Xinyi Liu; Zhengyang Liu
	1.1 web app function design	Xinyi Liu
	1.2 mobile app function design	Zhengyang Liu
	1.3 api_server design and construction	Yuming Jiang
	2. Drafted proposal presentation	Yuming Jiang; Xinyi Liu; Zhengyang Liu

Week 4	1. Literature review for proposal and proposal draft 2. Component design and confirmation	Yuming Jiang Xinyi Liu Zhengyang Liu
Week 5	**1. complete and submit proposal** 2. react-native study	Yuming Jiang; Xinyi Liu; Zhengyang Liu
Week 6	1. blockchain-system review 2. basic structure for api_server	Yuming Jiang
	3. configure the environment for react-native and build the basic framework for mobile app	Zhengyang Liu
	4. build the basic structure of the web app	Xinyi Liu
Week 7	1. executable basic web app	Xinyi Liu
	2. executable basic mobile app	Zhengyang Liu; Yuming Jiang
Week 8	1. first version of web app	Xinyi Liu
	2. first version of mobile app	Zhengyang Liu; Yuming Jiang
	3. well-function api_server and bigChainDB	Yuming Jiang
	4. test and integrate the whole basic system	Yuming Jiang; Xinyi Liu; Zhengyang Liu
Week 9	1. fix bug of the basic system	Yuming Jiang; Xinyi Liu; Zhengyang Liu
	2. add new features to the basic system 2.1 add new features to the web app	Xinyi Liu
	2.2 add new features to the mobile app	Zhengyang Liu
	2.3 update the api_server and adapter	Yuming Jiang
	3. complete and submit Progress Report	Yuming Jiang; Xinyi Liu; Zhengyang Liu
Week 10	1. add new features to the basic system 2. do some research and system review on UI design 3. confirm the basic UI design of the system	Yuming Jiang Xinyi Liu Zhengyang Liu
Week 11	1. second version system 2. test and debug for the final version 3. prepare for the presentation	Yuming Jiang Xinyi Liu Zhengyang Liu
Week 12	1. complete the presentation	Yuming Jiang; Xinyi Liu; Zhengyang Liu
	2. UI design 2.1 web app UI design	Xinyi Liu
	2.2 mobile app UI design	Zhengyang Liu; Yuming Jiang
Week 13	1. Integrate and implement all the parts of the system 2. whole system update and optimization	Yuming Jiang; Xinyi Liu; Zhengyang Liu
Week 14	**1. Final version system** 2. Drafted the final report	Yuming Jiang; Xinyi Liu; Zhengyang Liu
Week 15	**Final report submission**	Yuming Jiang; Xinyi Liu; Zhengyang Liu

Five milestones are set to evaluate and monitor the progress of the project, consisting of

complete and submit proposal, test and integrate the whole basic system, complete and submit progress report, final version system, and the final report submission. By now, we are finishing the first milestone and stay with the timeline.

Resources

1 Hardware

PC or Mac to write or build the code and test the web application.
Smart phone with Android 6.0 to test the mobile application.
Server with Ubuntu 14 to run the Api Server and BigchainDB.

2 Software

Visual Studio Code to write the React, Redux, NodeJS code.
Android Studio to build the React-native application.
GitLab to store the code, control the version and divide tasks.
Slack to communicate with each other.

Evidence of collaboration

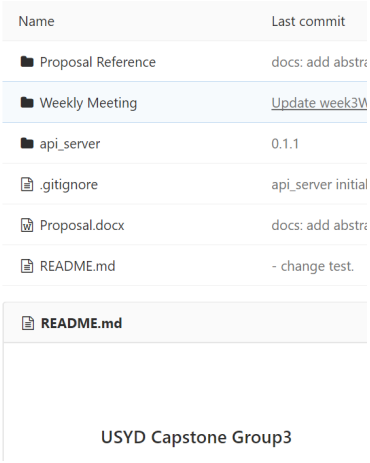

Figure 4. Repository

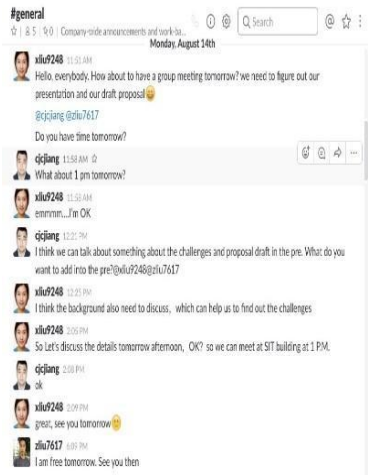

Figure 5. Slack

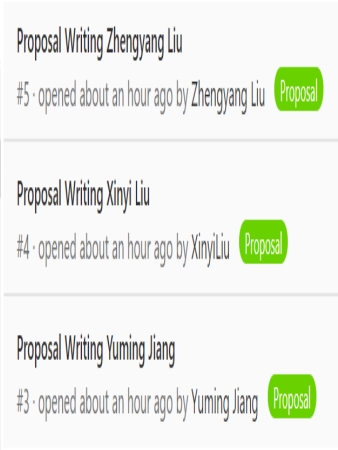

Figure 6. Issues

As shown in Figure 4, our weekly study note is uploaded to GitLab in folder Weekly Meeting. Also as shown in Figure 5, we communicated via Slack.
As shown in Figure 6, Yuming Jiang wrote first three parts of the methodology, user stories and resources, which is recorded in issue #3. Xinyi Liu wrote two parts of proposal, which are literature review and introduction of react, flux and redux, which is recorded in issue 4. Also, Xinyi Liu had the proposal typesetting, which is recorded in issue #7. Zhengyang Liu was responsible for the Abstract, other technologies in the methodology, and the timeline, which is recorded in issue #5.

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