Project Proposal

Project Title:	Peer-to-Peer Energy Trading
University:	Monash University Malaysia
Department:	School of Engineering
Competition Track:	Large-Scale Web Applications

1. Abstract

With growing populations and improved lifestyles, the demand for energy would only increase posing new challenges and problems to the energy sector. This project proposes a peer-to-peer web-based energy trading platform that is to be built utilizing Blockchain technology. The aim of this project is to optimize energy usage by homes, such that those that require higher amounts of it, can trade energy to make up for paying additional energy charges. The back end of the platform is to be built using the Golang programming language, while using the Angular framework for the front end. Moreover, the platform will also utilize a NoSQL cloud database called MongoDB to securely and reliably store its data. The platform will utilize smart contracts that are able to govern and control all the transactions made without any human's interference.

2. Project Introduction

As more people get access to electricity and have more money to buy bigger houses to live in filled with more appliances and electrical devices, it is only fair that the energy consumption for the average person throughout history has been increasing steadily [1], [2]. Grids in Malaysia are supplied with energy through main transmission lines that go from the generators all the way to distribution lines which then forward that energy to end users such as industrial, commercial, or residential users. It is in no doubt that as this demand and consumption for energy keeps increasing, at one point these transmission lines would have to be upgraded and renewed [3]. This would take a huge amount of time, resources and money, and if nothing is done the transmission lines will be extremely congested which is already starting to happen now during peak hours.

Another downfall of the energy sector according to consumers would be houses with solar panels who do not own batteries, are unable to store the generated surplus energy. They are not benefiting in any way from the surplus energy they generated as all of that energy is dissipated to the grid for free [4]. This reduces overall morale for the general public as they do not gain anything from the extra energy they produce and also demotivates them to use any kind of renewable energy generation in their house.

One way to combat and put an end to the aforementioned problems would be to implement a P2P Energy trading Blockchain platform. The P2P platform will allow sellers to be able to

provide surplus energy they generated for sale on the market, while consumers would then be able to buy it without needing to get electricity from the mains and as a result the overall demand and stress on the transmission lines would reduce [5][6]. Consequently, Infrastructure upgrade costs and resources can be invested in other projects as this upgrade will not be as necessary as before. Furthermore, an incentive will be created for people to buy their own solar panels at their house so they can start selling on the P2P platform. This will increase the number of people who are using renewable sources of energy, which will eventually lead to a cleaner and greener environment.

Integrating Blockchain in the energy trading environment would be a monumental improvement. It allows the whole market to be decentralized which makes people have more trust in the system as they know that it is not controlled by one single entity [7]. Not to mention that Blockchain enables the use of smart contracts which allows for a more transparent transaction process as the delivery of money and energy is monitored by the computer which minimizes the number of errors made. The use of smart contracts also allows for a more automated trading process among peers [8]. Therefore, it is no surprise that Blockchain could make some huge changes in the energy sector. Figure 1, on the next page outlines all the practical reasons for a peer-to-peer energy trading platform.

Fig. 1: P2P energy trading

There has already been multiple research and trials of implementing a P2P energy trading platform/environment in the past. The International Renewable Energy Agency (IRENA) issued a recent publication in July of 2020 detailing the benefits and possible gains from the implementation of a P2P trading platform [9]. There are many countries now who are currently using a P2P trading platform or at least conducted a pilot test to gauge feasibility. These countries include Germany, Japan, Malaysia, Netherlands, and many more [10].

3. Design Methodology

3.1 Database

A NoSQL database is the best choice for such an application because such databases can support storage of unstructured data unlike SQL databases [11]. In addition, unlike SQL databases, a NoSQL one will enable horizontal scaling, also known as ‘sharding’, which allows adding additional low- cost commodity hardware servers or clusters to be used, in other words, instead of one server serving the queries, two or more are [12]. This, of course, is very cost-effective compared to SQL databases where generally only vertical scaling is possible which involves upgrading the memory size/disk space/computing power of the single server storing the database [13],[14].

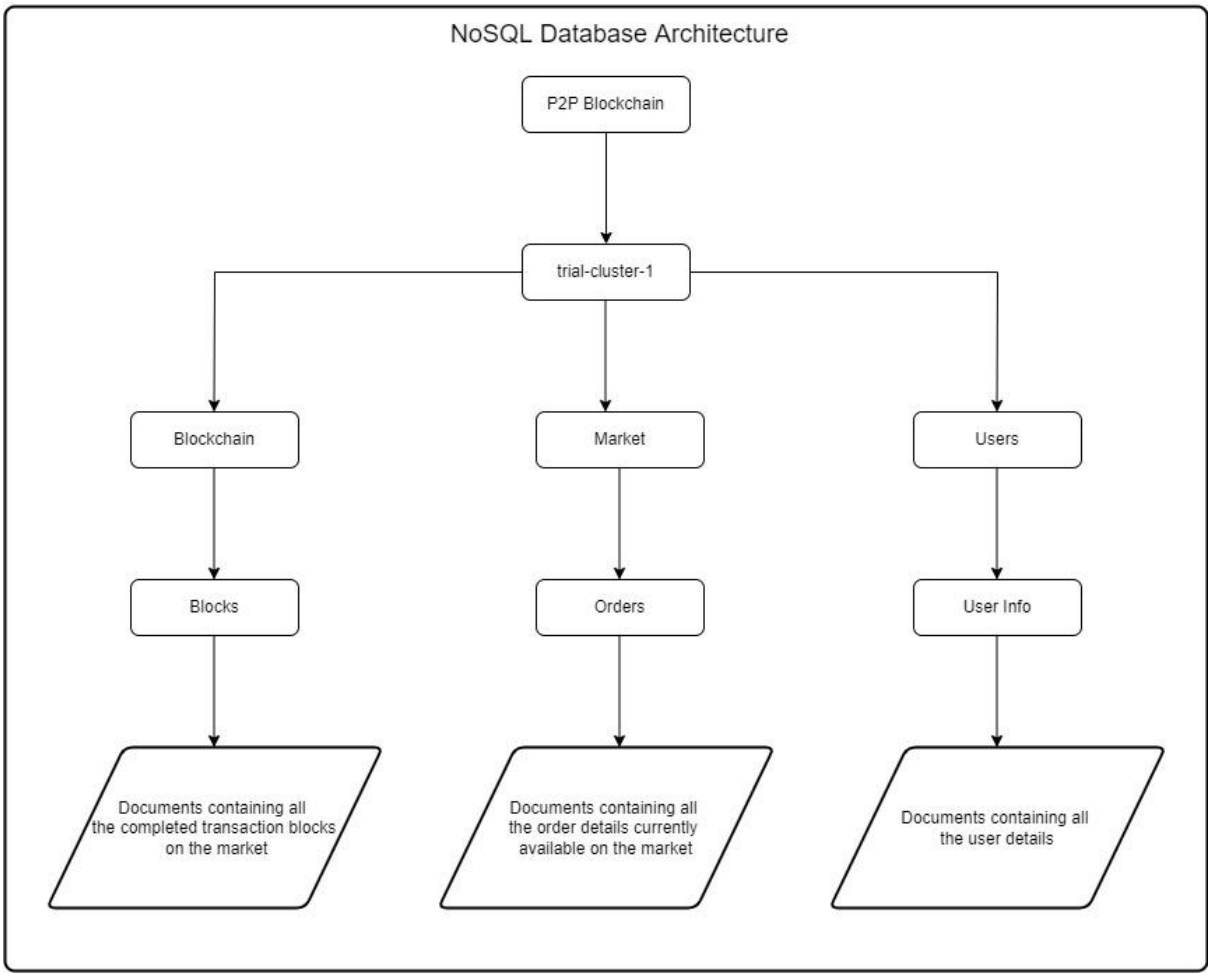


Fig. 2: Proposed database architecture.

As shown in Fig. 2, the plan is to split the entire database into three main components - the Blockchain cluster(leftmost) will have all the completed transactions. Each completed transaction is considered a block. The Market cluster(middle) will store all the issued buy or sell orders. Finally the Users cluster(rightmost) will store all the account details of users of the platform.

3.2 Backend

The back end is the middle layer of the platform, it takes requests made from the frontend and uses appropriate methods and data available from the database to fulfill these requests. The back end of the project is to be developed using the Go (Golang) Programming language for a plethora of reasons, but mainly due its speed, concurrency, and efficiency. The platform as of now will have three key features:

1. **Making a new order.**

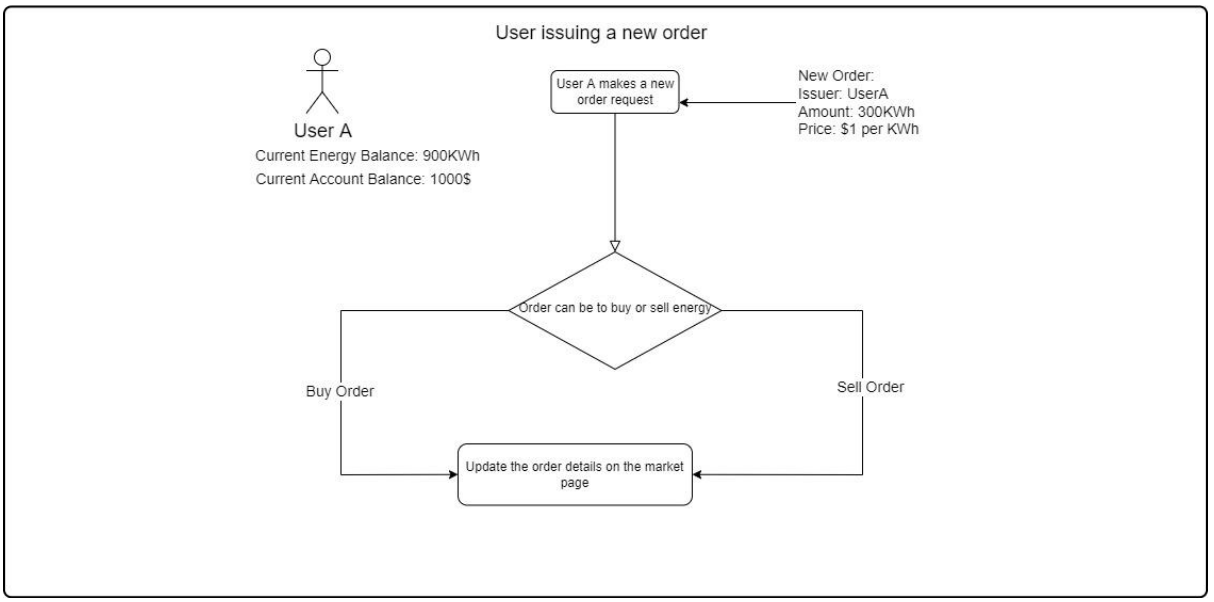


Fig. 3: Making a new buy/sell order

As shown in Fig. 3, when the user makes/issues a new order, it can be of two types: buy or sell order. For both order types, an entry will be made on the market page with the order details. The details of the order will be stored in the database under the Market cluster. The market page will have two separate lists, one for all issued sell orders made and one for all buy orders. Sellers will be able to view the buy order list to find a suitable client they can sell to. Buyers will be able to view the sell order list to find an offer that suits their needs.

2. **Transaction between two users**

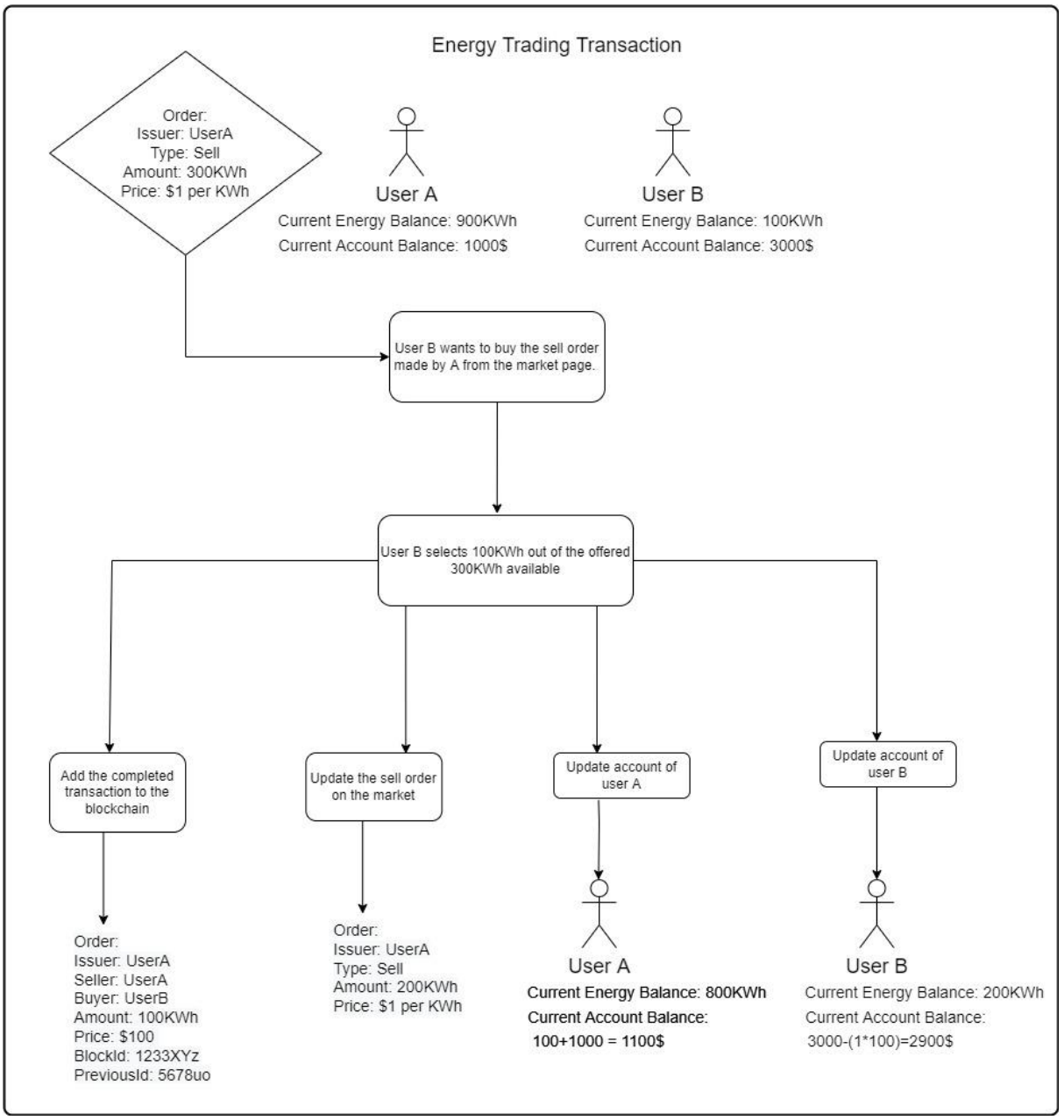


Fig. 4: Transaction between two users

Figure 4 above illustrates how a successful transaction will be handled. User A makes a sell order. User B sees the order on the market page and decides to buy a portion of the offered amount. As User B is the buyer, the money is charged on their account and their energy balance is updated accordingly. As for User A, they receive the funds and their energy balance is reduced to the amount sold. Since only a portion of the offer is sold, the order is updated on the platform and a new block is made on the global blockchain.

3. **Deleting an order**

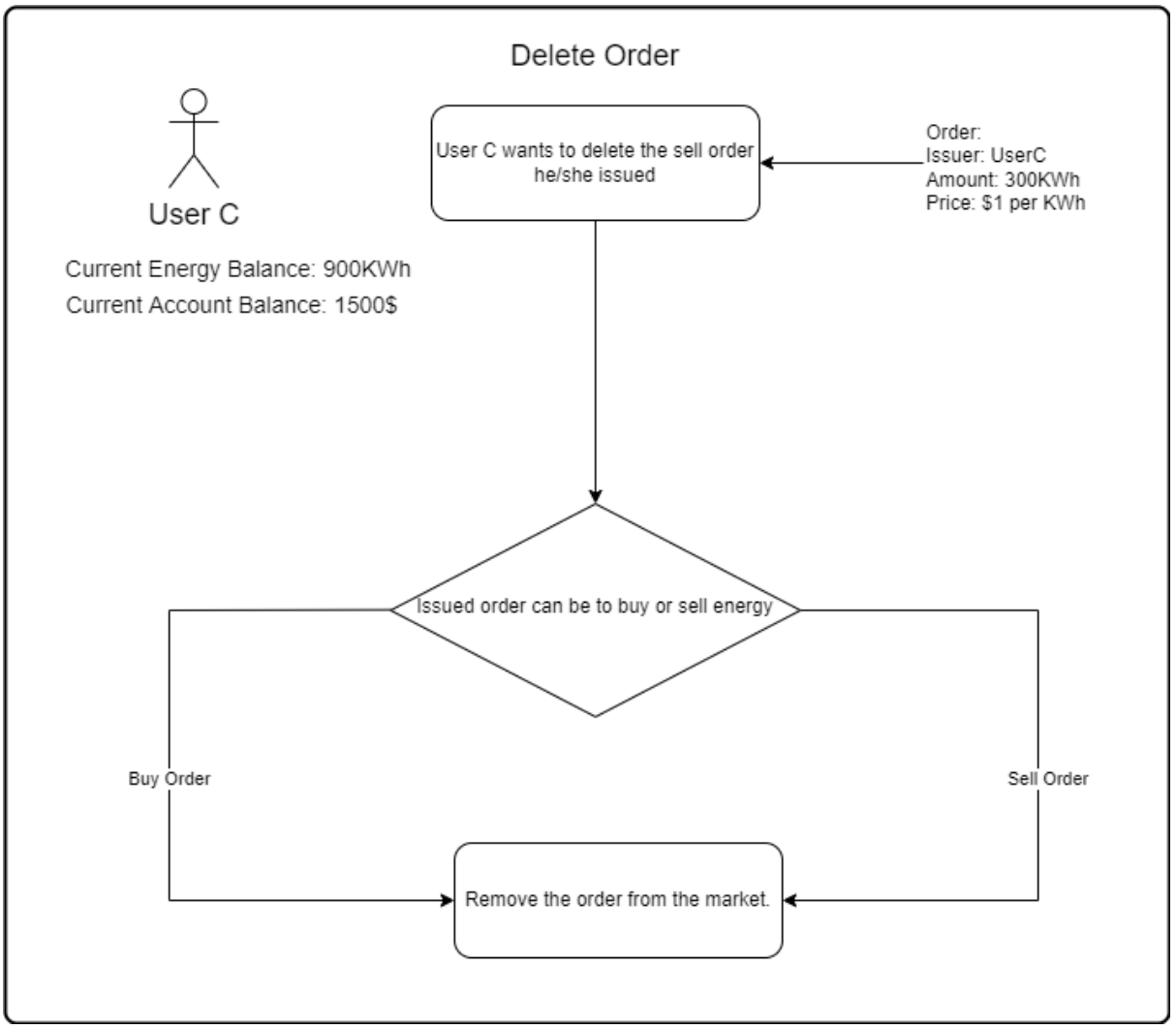


Fig. 5: Deletion of order

As Figure 5 illustrates, the user will have the option to delete a buy/sell order. In such a scenario, the order will be simply removed from the market page from the appropriate list.

3.3 Frontend

The front end allows the user to use the platform's features through a clean interface that is easy to understand. It interacts with the back end using RESTApis. The front end of the platform will be developed using the Angular framework which is an open-source front end framework, the decision to use Angular is made mainly because of its modularity and reusability. The user interface will be a responsive web application which means that the interface will adapt (respond) to the size of the device that is currently displaying it (i.e., Smartphone, Tablet, or Computer). Moreover, we will have form validation meaning that the user cannot submit forms until the data is entered correctly and is notified through visual cues by the interface that the data is invalid. The frontend will have the following modules:

1. **Homepage**: This is the web page the user will be taken to when they search for the platform's domain address.

2. **Sign-up and Login:** A Sign up page that can be accessed from the homepage, to create an account on the platform. Once an account is made the user will be able to login by providing the credentials.
3. **Session Token:** A session token to remember the user details until the user logs out. The session token will be stored in the local storage of the browser and the information in it will be encrypted.
4. **Landing Page:** Upon login, the user will be taken to a Landing page. This page will allow them to make buy and sell orders.
5. **Market Page:** This page shows all the sell and buy orders, in two separate lists, issued by other users as well as the orders made by the user themselves.
6. **Blockchain Page:** This page shows all the successful transactions that have taken place so far on the platform.
7. **Profile Page:** This page allows the user to customise his/her account details.

The proposed frontend design is illustrated below:

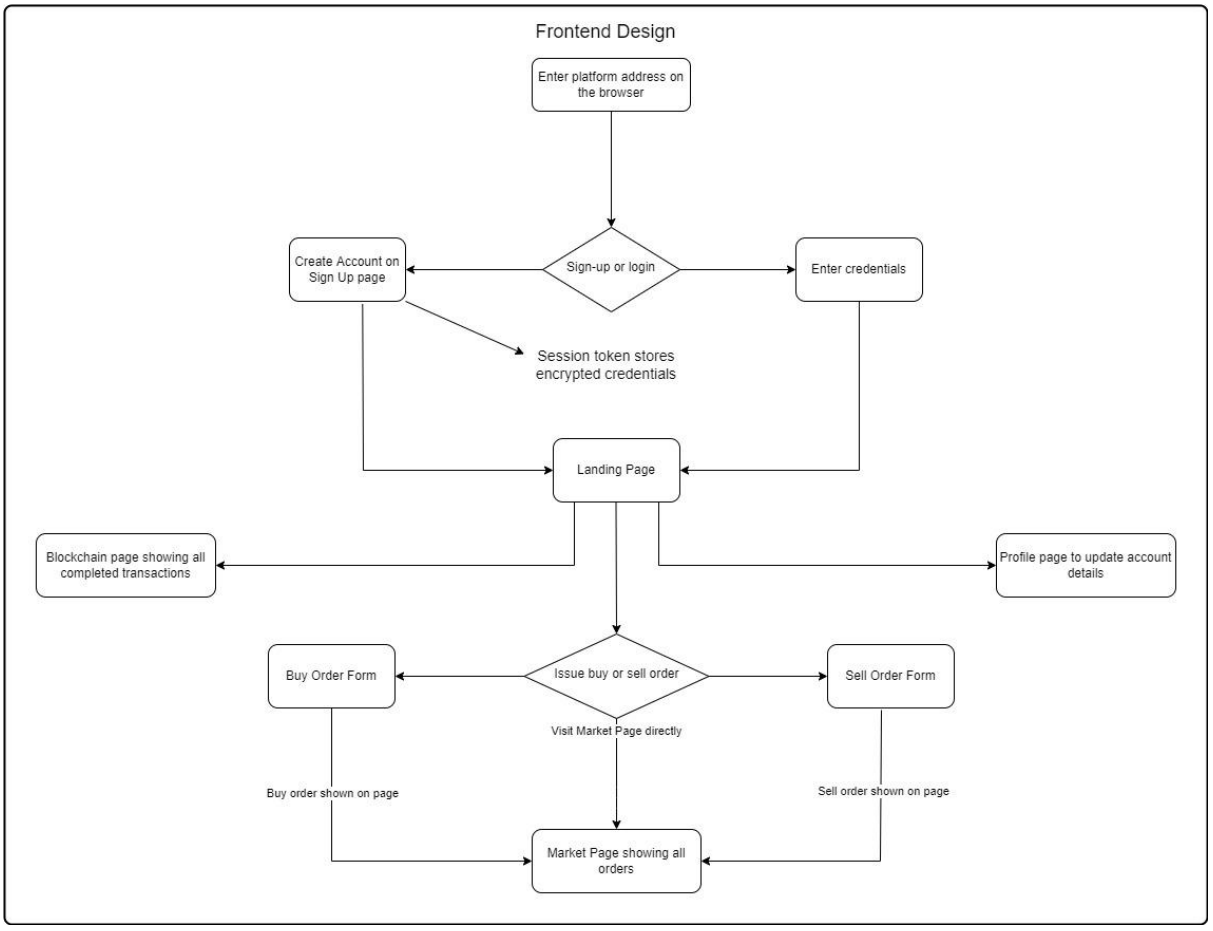
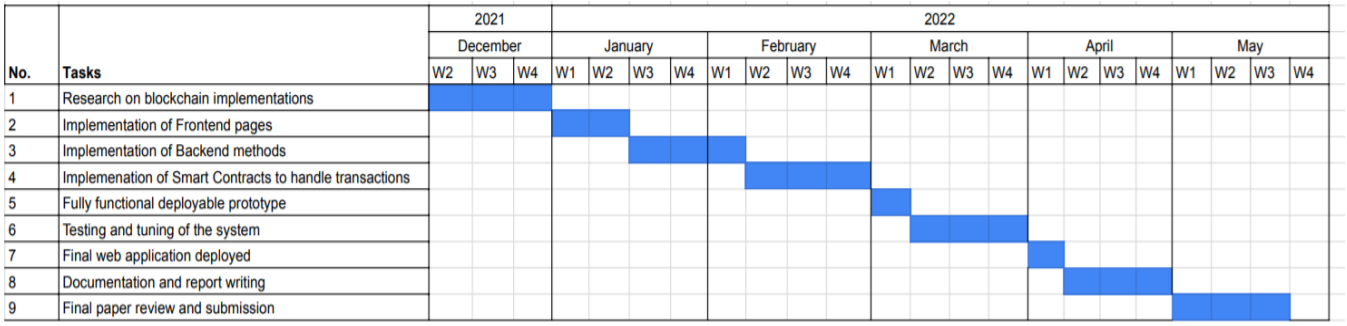


Fig. 6: Frontend design to map onto the backend.

As the system is implemented, our understanding of the project would also improve. This may result in addition of new features to the system. With that said, Figure 7 below shows the predicted progress timeline of the system.



No.	Tasks	2021			2022																			
		December			January				February				March				April				May			
		W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
1	Research on blockchain implementations																							
2	Implementation of Frontend pages																							
3	Implementation of Backend methods																							
4	Implemenation of Smart Contracts to handle transactions																							
5	Fully functional deployable prototype																							
6	Testing and tuning of the system																							
7	Final web application deployed																							
8	Documentation and report writing																							
9	Final paper review and submission																							

Fig. 7: Gantt chart of project

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