



Final Report



CSCI5409: Advanced Cloud Computing

Group 40 (Team 3): Stormtroopers

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Overview

As the trend of Fintech and digitalization is hitting the global market at a much pace, many companies are utilizing innovation and offering numerous services related to finance and technology. Cryptocurrencies have evolved with digital payments systems and digital wallets expansion over many years. There are thousands of cryptocurrencies available in the market, where bitcoin was the first one founded and is still the best known today. Cryptocurrencies transactions and exchanges are traded daily with a large, estimated number of active users worldwide. Furthermore, all the companies prefer to host and deliver their websites on a cloud platform for better performance, scalability, reliability, and flexibility of the services. The combination of Fintech website and cloud computing platform is a game-changing digital transformation.

Stormtroopers, as a team, will implement a cryptocurrency exchange website 'Krypton' on Amazon Web Services (AWS) cloud platform to deliver an application with the latest technologies. Krypton will let users log in or register to buy or sell any cryptocurrency with a more user-friendly website. Along with the transactions, the user will get the option to check the market trends, latest market news, a personalized prediction model of the crypto currencies available in the user holding's wallet. It will provide the user with a decision-making platform and the flexibility to use many features in one place. Also, the visualization graphs will have a unique effect on the statistical analysis of personal holdings with the market trends. The development of each feature will be complete considering the security, privacy, and performance of the website on the AWS platform. The AWS services such as Virtual Private Network, EC2 instance, DynamoDB, Amazon Cognito, Elastic Load Balancing will deploy and deliver the website on the cloud as a Software as a Service (SaaS) platform because the web application will be available as software for use. The developers will use the AWS services to build all the website features such as Homepage, dashboard, holdings, wallet, trade, and personalized prediction. But the users will directly use the services and not access the infrastructure, storage or network used to develop the website. The goal is to provide a flexible and high-performance user experience with Krypton. Various API calls will help reach the crypto market and fetch the data for the users.

Although numerous websites have recently started to provide cryptocurrency-related information, there is still a significant market demand for alternatives easier to use and comprehend. Krypton is committed to providing users with thorough, high-quality, practical market research on the cryptocurrency market. Krypton will provide users with unrivalled insights into the market through a seamless and tailored approach by offering a prediction feature that estimates the value of a cryptocurrency based on real-time data and past data. Also, it will allow users to keep an eye on their preferred cryptocurrencies through a personalized watchlist feature.

Krypton will be a decentralized application built using Python, JavaScript and various on-demand AWS cloud services for the back end, front-end development, and integration of backend and front-end. Team stormtroopers believe that Krypton will outshine on the speed front, where users can expect fast and seamless access to the information daily. Thanks to the features and functionalities of cloud computing platforms, such as on-demand availability of the computer system resources and the ability to distribute the website across multiple locations.

How do all of the cloud mechanisms fit together to deliver your application?

Repository URL: <https://git.cs.dal.ca/msareen/cloud-stormtroopers.git>

Table 1 lists the AWS services planned for the delivery and deployment of the Krypton website on the AWS cloud.

Table 1: List of services to deploy the web application on AWS cloud

CATEGORY	SERVICES
COMPUTE	AWS EC2 Docker & AWS Elastic Beanstalk AWS Lambda
STORAGE	AWS S3 AWS DynamoDB
NETWORK	AWS Virtual Private Cloud Amazon EventBridge
GENERAL	Amazon Cognito AWS SNS AWS Secret Manager AWS Elastic Load Balancing AWS Cloud formation for resource provisioning Gitlab CI/CD pipeline for deployment

Compute, Storage, Network, and Security are the main cloud mechanisms that played a significant role in the development of our web application. We have used elastic beanstalk and gitlab ci/cd pipeline to build and deploy the code on the code, which contains the EC2 instances and the load balancer to handle and route the traffic from the outside sources. The VPC network was created to add security to the website. The EC2 instances are created in the private subnet and the load balancer is created in the public subnet of the VPC. The elastic IP address is added to receive and route the traffic to the VPC. NatGateway is configured in the public subnet of the VPC to receive the traffic from the elastic IP and route to the private subnet where EC2 instances are created. The DynamoDB and S3 buckets are attached to the VPC endpoint, so that traffic is routed via VPC and not directly. The Cloud formation stack is used to provision all the resources on the AWS public cloud where the json file is stored in the S3 bucket. Once any guest opens the website, a home page appears where all the top markets cryptocurrencies data is displayed. The live data on the home page is scheduled through the lambda function and the AWS EventBridge after every 10 mins which stores the data in the DynamoDB tables. The data from the DynamoDB tables is then displayed on the home page. If any guest wants to buy/sell cryptocurrency, registration is required either using Cognito User Pool or Facebook. Amazon Cognito administers the authentication aspect of the application by quickly enabling user authentication and user management, ensuring

the cloud application's security. Once a user registers, SNS notification is sent to that user to subscribe to the Email notifications in the future for any trading transaction. All the resources IDs and API keys are stored in the secrets manager to make the application more secure and dynamic.

Where is the data stored?

The live data of the top market cryptocurrency and the exchange rates are stored in the DynamoDB tables which are scheduled after every 10 minutes. The users email and password are stored in Amazon Cognito. Then the users information specific to an account are stored in the users_information table in DynamoDB. Also, all the cryptocurrency transactions data are stored in the users_transaction table in the DynamoDB.

Our program's database and storage components are built using industry best practices, avoiding complexities, interdependencies, and tight coupling between application components. The data flow in the app starts with the user supplying information from the frontend on events like clicks, hovers, and more. These events cause functions to be called that connect to the backend cloud services via Application Program Interfaces (APIs). The APIs used are GET, POST, and PUT to fetch, send, and update data to AWS DynamoDB.

What programming languages did you use (and why) and what parts of your application required code?

We used the following programming languages to build our application:

Frontend

For frontend, we have used HTML programming language which interacts with the JavaScript to build and route the pages and create connect between the frontend and the backend.

Backend

For backend, we have used python and flask app to define and call all the functions and services and listen to the routing sent by the JavaScript program.

AWS Cognito, AWS DynamoDB, and AWS SNS cloud services need cloud service integration in Code Coding. The AWS Cognito service was integrated in the frontend with the aid of the amplify library to authenticate and register web application users. To interface with AWS DynamoDB and AWS SNS, the backend used the AWS-SDK library. APIs were built to enable the transfer of application data in conjunction with the cloud services integration. We created an application frontend using code that provides a user interface and consumes data from APIs.

How is your system deployed to the cloud?

Using Cloud Formation, we provisioned all our project's cloud services on AWS. We created `awsCloudFormation.json`, that provisioned services such as Virtual Private Cloud (VPC), including subnets and associated security groups for the instances within the VPC, Cognito, DynamoDB, EC2, and Elastic Beanstalk. We used Simple Notification Service (SNS) as our notification system directly through the code because it did not require provisioning.

Cloud Formation is used to deploy a portion of our application automatically. Then the code is deployed to the elastic beanstalk using CI/CD pipeline which creates a docker image and deploys the docker image to the beanstalk container.

If your final architecture differs from your original project proposal, explain why that is. What did you learn that made you change technologies or approaches?

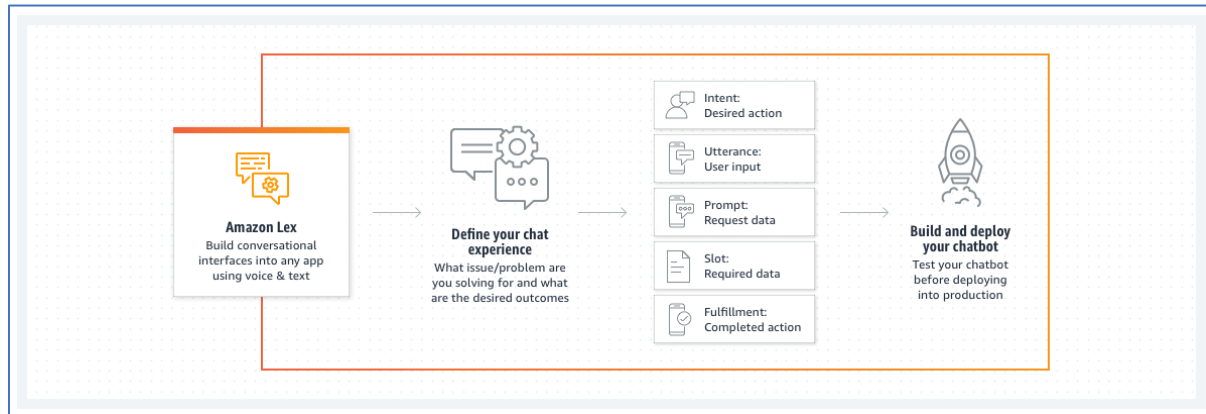
Our proposed architecture is a bit different from the final architecture as below:

1. Previously we were deploying the EC2 instances and the load balancer in the public subnet. But now, we have deployed EC2 instances in the private subnet keeping the load balancer in the public subnet.
2. We were not using NATGateway and Elastic IP, but now we have configured that with the VPC to securely re-route the traffic.
3. We added lambda and EventBridge to update the website with the live data.
4. We attached the DynamoDB and S3 services to the VPC endpoint for security purposes.

We learnt that it is very important to secure the website on the public cloud and configure the services accordingly. Also, we learnt the importance of live data storage in the databases and how they should be configured.

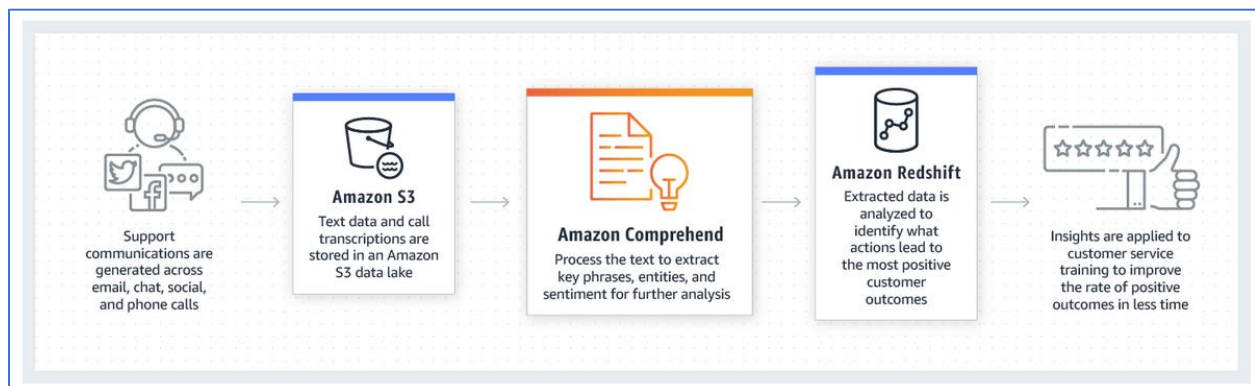
How would your application evolve if you were to continue development? What features might you add next and which cloud mechanisms would you use to implement those features?

With sufficient time and development, the application can evolve into a get-to-market level, handling at least 5000+ coins and providing tailored predictions for each user. For ease of users, we can integrate chatbots, for this purpose we can use **Amazon Lex**.

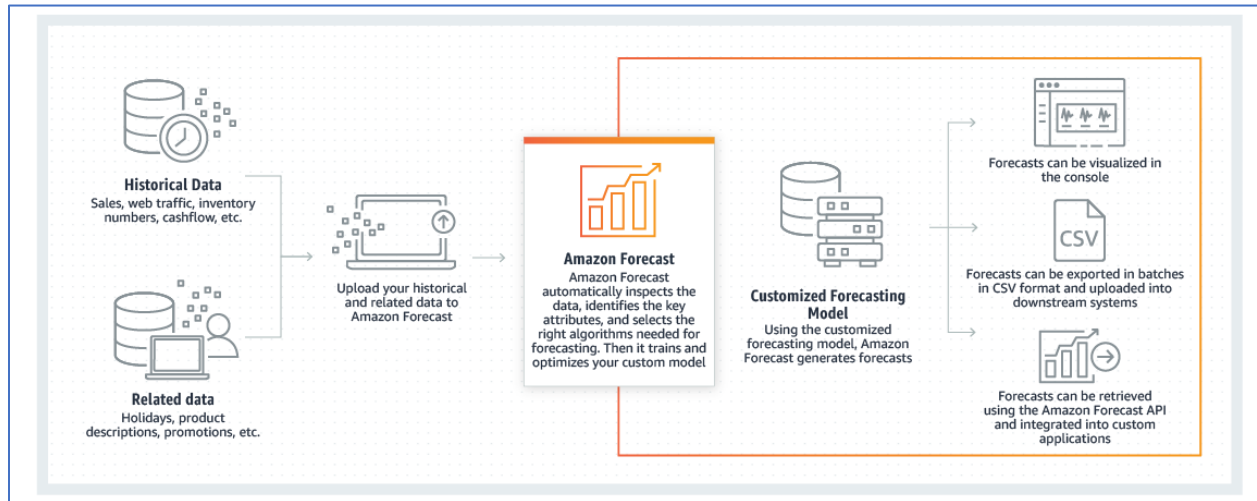


Multi-Language support is a crucial element in websites to serve a wide range of audiences: we can integrate **Amazon Translate** for this very purpose.

In dashboard: the option to view sentiments of the selected currency can be added to get an estimation of public opinion. This can be accomplished by retrieving tweets and internet polls and submitting them to **Amazon Comprehend**. This service could also be useful for analyzing chatbot conversations to iterate and enhance our web application as per user feedbacks.



For routing API requests to lambda for updating respective DynamoDB tables securely we could add **AWS API Gateway**, which we were not able to due to restriction of Academy account. Extending the use of existing cloud mechanisms like **AWS SNS** to send transaction response related emails and **Amazon Cognito** for forgot password option. For prediction of a cryptocurrency, we can implement **Amazon Forecast** which is a time-series forecasting service based on Machine learning. That forecasts could be then visualized for the users.



Existing Features and Functionalities

Team Stormtroopers has come up with Krypton which is a cryptocurrency trading broker website where users can register/log, see the current trends and buy/sell Cryptocurrencies. Customers can manage their cryptocurrency portfolios and conduct transactions with a user-friendly website hosted and maintained on the AWS cloud platform. In this section we will go through each component of the website in detail.

The Index Page:

Now that we have seen the infrastructure and the cloud formation. Its time to fire up the application and see these different cloud mechanisms in play.

The very first landing page of the website is the Index page, which has various components starting from navigation bar for the user to navigate to different sections of the website to the footer containing various social media links covering various cryptocurrency trends, live data of top cryptocurrencies, Latest news trends of other top cryptocurrencies and much more. The navigation bar provides the user with the ability to login/ register to join the community, “buy crypto” to take up some holdings and buy and sell cryptocurrencies, User can visit the “about us” section to know about the team stormtroopers and the credits section to show our various references and resources.

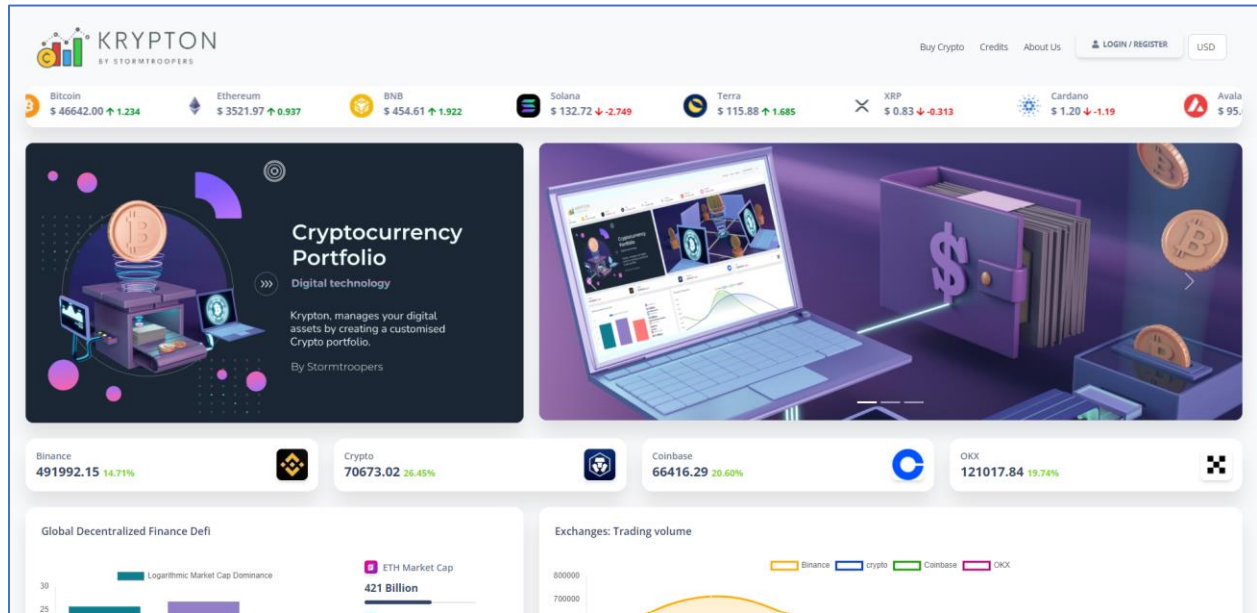


Figure 1: Marquee and latest exchanges.

There is a marquee tab which shows the latest cryptocurrency prices for the top cryptocurrencies. Followed by some introductory images in a slider format explaining the website gives us an overview to the user who comes to the website giving him intriguing features. There is also a row showing the top trending exchanges and their current volume. If there is a growth in this volume in the last 24 hours, this percentage growth is displayed in green and when a decrease, it is shown in red.

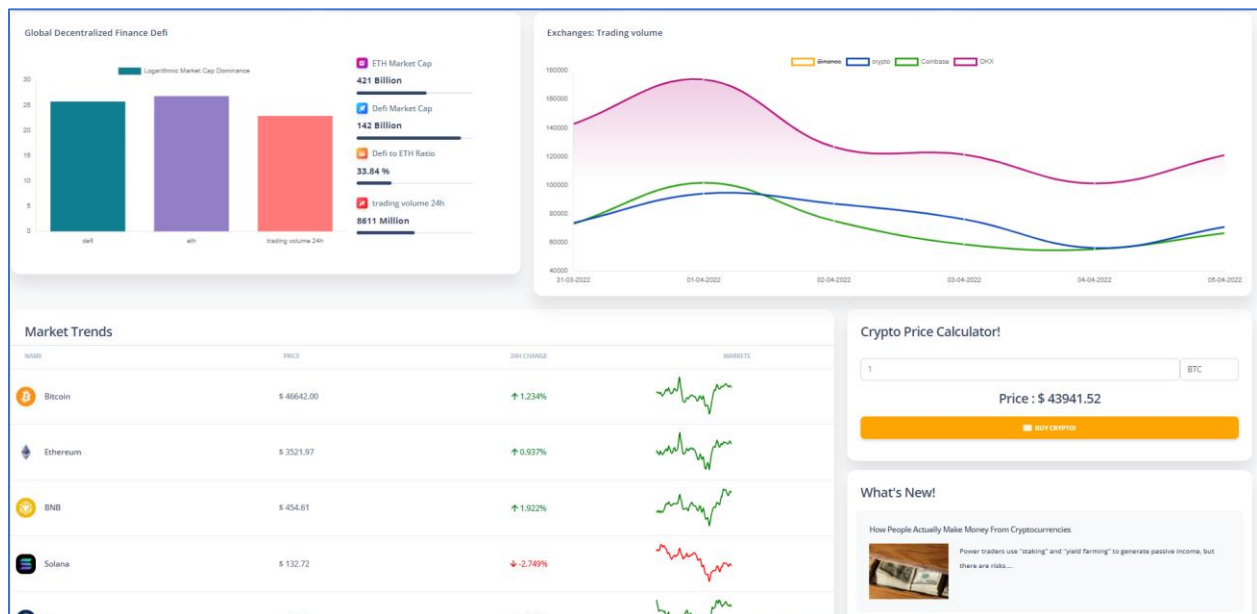


Figure 2: Other bits of the Index Page.

The Exchanges trading volume chart shows volume trends over one week. This live data is fetched using AWS Lambda scheduling jobs running in 10 minutes and is fetched from Coingecko endpoints and are stored in the Dynamodb which is then used for fetching and displaying the data.

The Global Decentralized Finance bar chart or “DEFI” as the traders call it today shows the comparison between the Ethereum and its various metrics like Market cap, ETH ratio and trading volume in the last 24 hours.

The Market trends section shows the latest trends of the top cryptocurrencies with their price, 24h change. It also shows different trends and based on the current 24h change, the look of the graph changes to green or red based on percentage variations.

The Crypto price calculator allows the user to check the current price of the currencies, and this can be changed based on the currency the user wants to see the current price for different cryptocurrencies he selects. The user can also choose different currencies of various locations from the navigation bar to various options like USD, CAD, INR, EUR etc. Based on these exchange rates the user can see the price in their selected currency and see the amount based on various quantities he selects.

The What’s New section shows the latest trending news regarding various top cryptocurrencies. The news is fetched using the API from the NewsAPI endpoint. The credentials for this API are stored in the Secrets Manager.

The Login and Register Page:

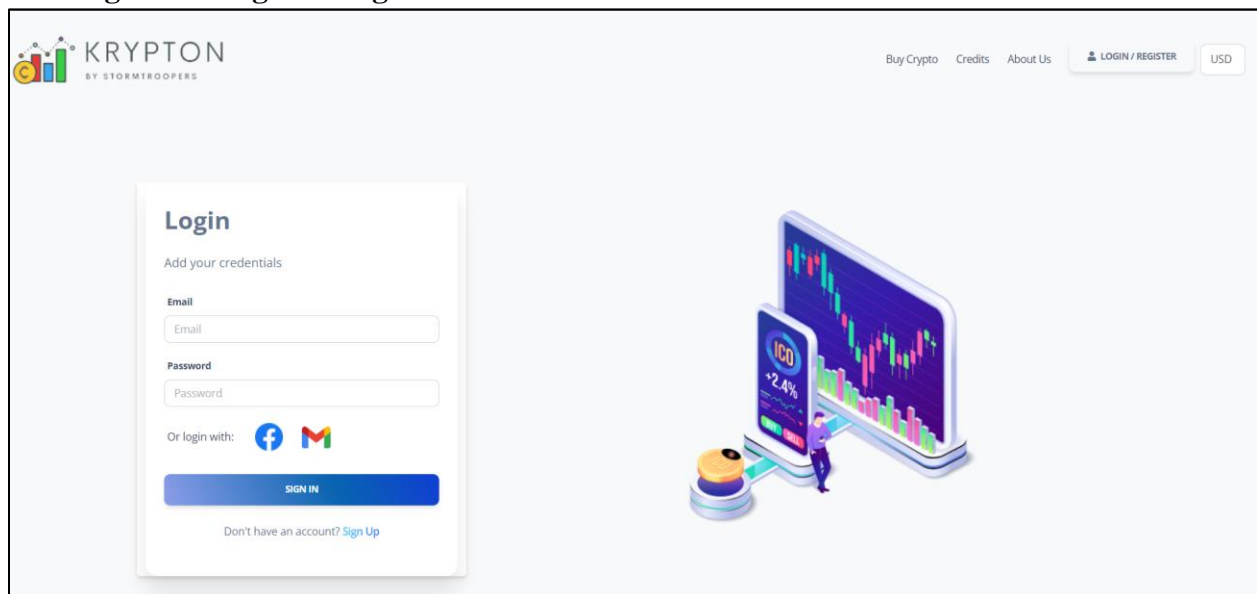
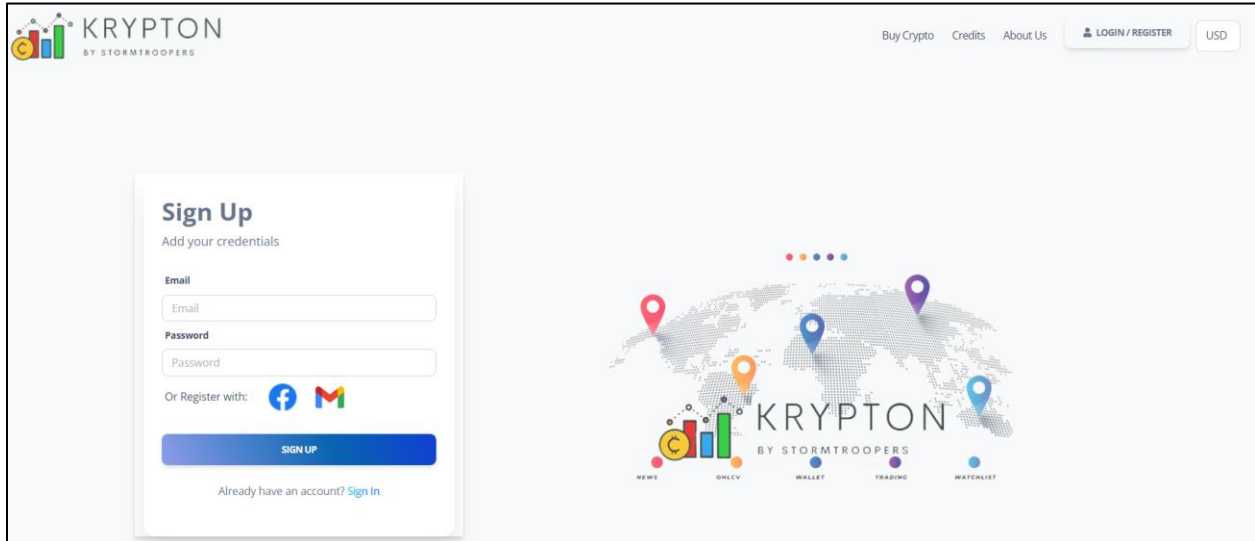


Figure 3: Login Page.



The register page features the Krypton logo (a bar chart with a coin) and the text "BY STORMTROOPERS". Navigation links include "Buy Crypto", "Credits", "About Us", and "LOGIN / REGISTER" with a "USD" dropdown. The main "Sign Up" form includes fields for "Email" and "Password", a "SIGN UP" button, and social media login options for Facebook and Google. A link for "Already have an account? Sign In" is at the bottom. To the right is a world map with location pins and a secondary Krypton logo with navigation links: "NEWS", "DISCOVER", "WALLET", "TRADING", and "WATCHLIST".

Figure 4: Register Page.

The Login and Registration in Krypton is done with Amazon Cognito. Validating and responsible for managing the user pool and session we have also supported social media sign in and registration as well. Handling the user management settings like different validations, password allowance like what characters are allowed in a password, how many symbols should be present, whether there should be a lowercase and uppercase allowed in a password and other password policies are all managed by Cognito. We have also used AWS SNS to send confirmation messages on successful registration of the user.

The Dashboard Page:

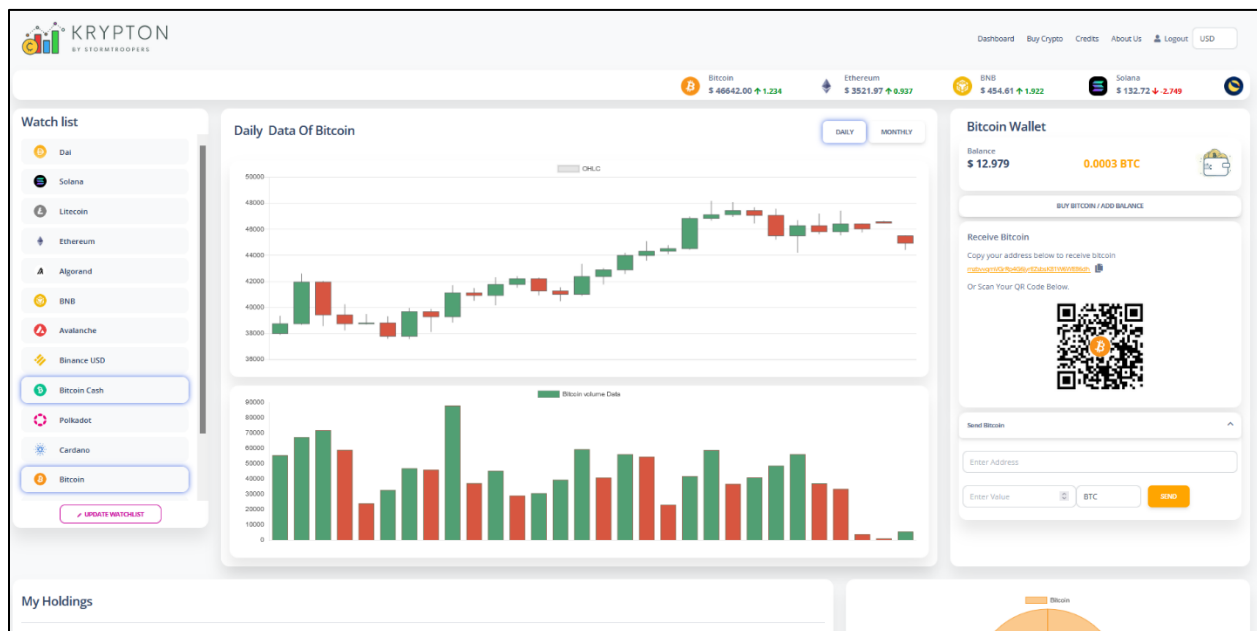


Figure 5: Dashboard Page.

On Successful login, the user lands on the dashboard page. It contains the Bitcoin Wallet, a personalized watchlist for the user, Various graphs showing the Open, Closed, High, Low, Volume of the graphs. It also shows the holdings and assets of the user.

The BTC Wallet is allotted to every new user which is used for trading different cryptocurrencies and exchange bitcoins among users. In the watchlist we have given a few top coins already to the user along with some random coins which the user cannot remove and our webapp uses it while trading. Every new user gets a random watchlist with a few top mandatory coins since we are dealing with those while trading. There is also a candlestick graph and a bar graph which we see in the dashboard. The candlestick graph shows the trends of the “open”, “high”, “low”, “close” prices of last 30 days in daily and last 12 months in monthly. The bar graph below shows the volume in the last 30 days. Additionally, we have given an easy representation to the user displaying how the volume has increased or decreased in comparison with its previous days. The color red represents a decrease than previous day volume and the color green shows increase in volume. The Holding section show the assets and holdings the user has.

The user can update the watchlist based on his choices and the currencies he wants to keep an eye on.

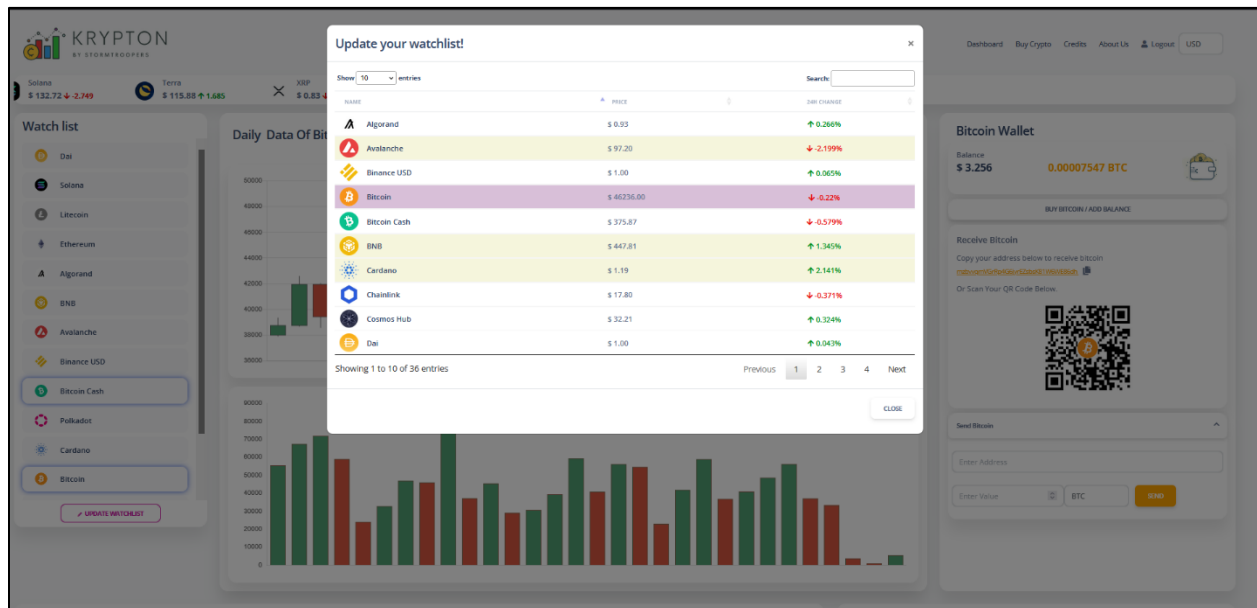
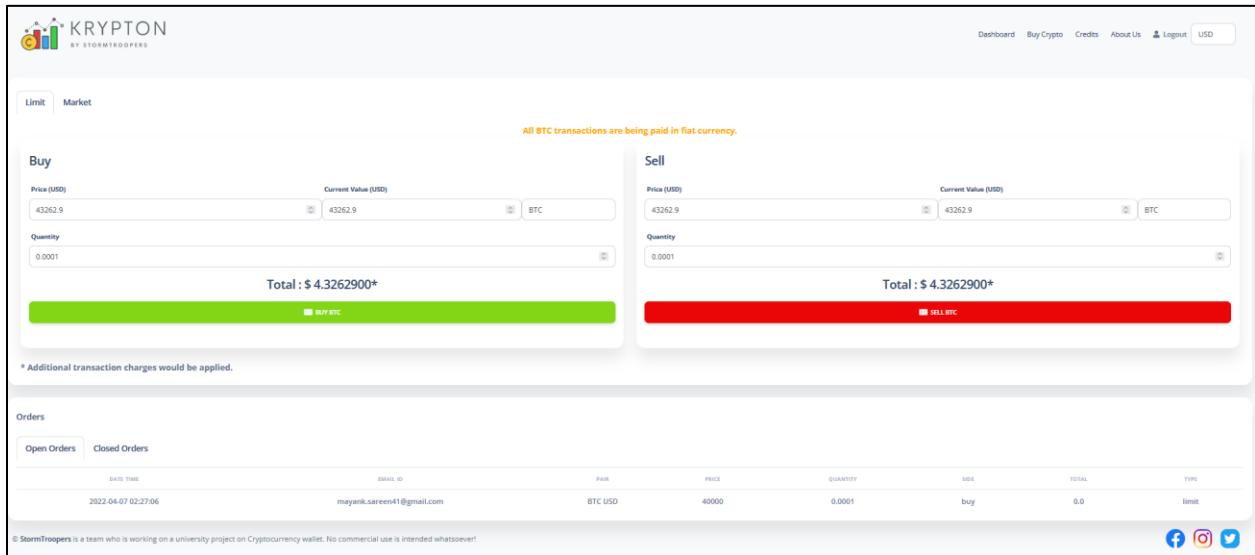


Figure 6: Updating the watchlist

The Trading Page:

This page for the user to get some holdings by buying and selling cryptocurrencies. Two options Limit and Market: When a user tries to buy a cryptocurrency for a self chosen price. If that price is different from current value, it is an open order and when the price matches it becomes the closed order. And in market the user can directly buy.



KRYPTON
BY STORMTROOPERS

Dashboard Buy Crypto Credits About Us Logout USD

Limit Market

All BTC transactions are being paid in fiat currency.

Buy

Price (USD) Current Value (USD) BTC

Quantity

Total: \$ 4.3262900*

BUY BTC

Sell

Price (USD) Current Value (USD) BTC

Quantity

Total: \$ 4.3262900*

SELL BTC

* Additional transaction charges would be applied.

Orders

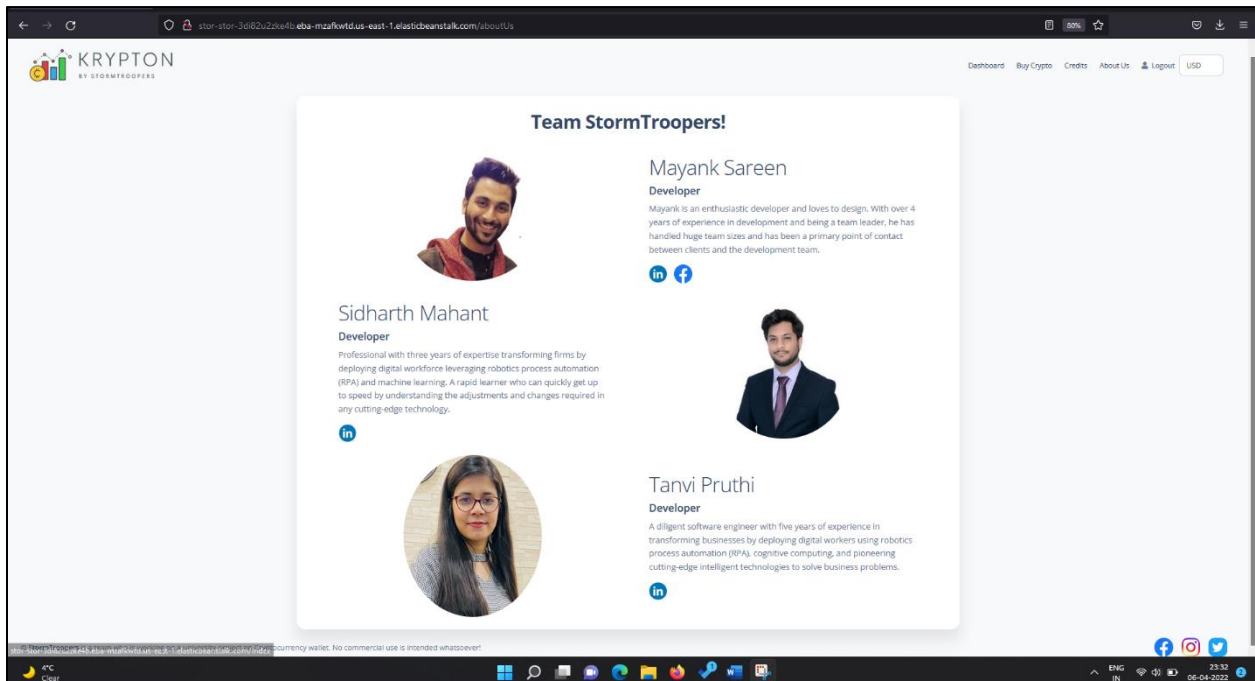
Open Orders Closed Orders

DATE TIME	EMAIL ID	PAIR	PRICE	QUANTITY	SIZE	TOTAL	TYPE
2022-04-07 02:27:06	mayank.sareen41@gmail.com	BTC USD	40000	0.0001	buy	0.0	limit

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Meet the team:



KRYPTON
BY STORMTROOPERS

Dashboard Buy Crypto Credits About Us Logout USD


Team StormTroopers!



Mayank Sareen
Developer

Mayank is an enthusiastic developer and loves to design. With over 4 years of experience in development and being a team leader, he has handled huge team sizes and has been a primary point of contact between clients and the development team.


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Sidharth Mahant
Developer

Professional with three years of expertise transforming firms by deploying digital workforce leveraging robotics process automation (RPA) and machine learning. A rapid learner who can quickly get up to speed by understanding the adjustments and changes required in any cutting-edge technology.

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Tanvi Pruthi
Developer

A diligent software engineer with five years of experience in transforming businesses by deploying digital workers using robotics process automation (RPA), cognitive computing, and pioneering cutting-edge intelligent technologies to solve business problems.

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