VSCrypt

(Blockchain based E-voting System)

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In the name of Allah, the most merciful, the most beneficent.

ABSTRACT

Technology has a very deep social impact on our lives in today’s world. With the increase in technology, humans are prone to comfort, compared to what they were some years ago. VsCrypt being one of the useful application based on the emerging technologies of present era is proving to be alot useful and trustworthy. A web based application is proposed as a solution for improving the current voting system in the country.

The idea of the project VSCrypt is to develop a Blockchain based secure E-Voting system which tends to use decentralized architecture integrated with blockchain and cryptographic algorithms ensuring transparency, security, authorization and privacy for the democratic elections being held in the country.This document is meant to outline the features and requirements of VSCrypt, to serve as a guide to the developers and a software validation document for the prospective client on the other.

A web based application has been developed for the government, general public and political parties targeting the election system in the country, followed by 5 main modules normally developed in a virtual environment, subject will have to register themselves as a voter or an administrator for gaining different access and casting the vote. Results will be displayed at the end to analyze subject’s performance. The results of the evaluation revealed that application has potential benefits and provides a stronger system in order to vanish the current voting system and disable the use of conventional ballot system by improved, efficient and transparent system based on blockchain.

CERTIFICATE FOR CORRECTNESS AND APPROVAL

It is certified that work contained in the thesis VsCrypt, Blockchain based E-voting system carried out by Aayesh Umar, Momina Haleem and Saba Saif Gondal under supervision of Dr. Saddaf Rubab for partial fulfillment of Degree of Computer Software Engineering is correct and approved.

Approved by

Dr. Saddaf Rubab

Assistant Professor

Department of CSE

MCS, NUST

Dated: 10 June 2019

DECLARATION

No portion of work presented in this dissertion has been presented in support of another reward or qualification either at this institution or elsewhere.

DEDICATION

To our parents, without whose support and cooperation, a work of this magnitude would not have been possible. To our supervisor, Dr. Saddaf Rubab who has given us great support and valuable suggestions throughout the implementation process.

ACKNOWLEGEMENTS

There is no success without the will of Allah Almighty. We are grateful to Allah, who has given us guidance , strength and enabled us to accomplish this task. Whatever we have achieved, we owe it to Him, in totality. We are also grateful to our parents and family and well- wishers for their admirable support and their critical reviews. We would like to thank our supervisor Dr. Saddaf Rubab for her continuous guidance and motivation throughout the course of our project, without her help, we would not have been able to accomplish anything.

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1. Introduction

The introduction of the Software Requirements Specification (SRS) provides an overview of the entire SRS with purpose, scope, definitions, acronyms, abbreviations, references and overview of the SRS. The aim of this document is to present detailed description of the project VSCrypt in which the existing system of the general elections is discussed, the problems faced during the elections and the best possible solution is being proposed.

1.1 Purpose

This document covers the software requirement specifications for the project VSCrypt. The idea of the project VSCrypt is to develop a Blockchain based secure E-Voting system which tends to use decentralized architecture integrated with blockchain and cryptographic algorithms ensuring transparency, security, authorization and privacy for the democratic elections being held in the country.This document is meant to outline the features and requirements of VSCrypt, to serve as a guide to the developers and a software validation document for the prospective client on the other.

1.2 Document Conventions

This section describes the standards followed while writing this document.

1.2.1 Headings

Heading are prioritized in a numbered fashion, the highest priority heading having a single digit and subsequent headings having more numbers, per their level.

All the main headings are titled as follows: single digit number followed by a dot and the name of the section (All bold Calibri (Body), size 18, Centered).

All second level sub headings for every sub section have the same number as their respective main heading, followed by one dot and subsequent sub heading number followed by name of the sub section (All bold Calibri (Body), size 16).

Further sub headings, i.e. level three and below, follow the same rules as above for numbering and naming, but different for font (All bold Calibri (Body), size 14).

1.2.2 Figures

All figures in this document have captions, and are numbered. Context and flow diagrams are based on UML standards.

1.2.3 Reference

All references in this document are provided where necessary, however where not present, the meaning is self-explanatory. All ambiguous terms have been clarified in the glossary at the end of this document.

1.2.4 Links to web pages

All links have been provided with underlined font, the title of the web page or e-book is written at the top of the link and the title may be searched on google to pinpoint to the exact address.

1.2.5 Basic Text

All other basic text appears in regular, size 12 Calibri (Body). Every paragraph explains one type of idea.

1.3 Intended Audience and Reading Suggestions

The intended audiences for the VSCrypt include the project supervisor, the BESE 21 FYP group (developers), UG project evaluation team, and other persons at MCS CSE Department.

1.3.1 Project Supervisor

It will help the supervisor to supervise the project and guide the team in a better way. This document will be used by her to check whether all the requirements have been understood and in the end whether the requirements have been properly implemented or not.

1.3.2 BESE 21 FYP group (developers, testers, and documentation writers)

For FYP group members, this document will provide the guidelines for developing and testing the project.

1.3.3 UG Project Evaluation Team:

It will help the evaluation team to evaluate the progress of FYP project. The document will provide the evaluators with the scope, requirements and details of the project to be built. It will also be used as basis for the evaluation of the implementation and final project.

1.3.4 Reading suggestions

The SRS begins with the title and table of contents. All level 1 and level 2 headings are given in the table of contents, but the lower sub headings are not included. Each main heading is succeeded by several sub headings, which are all in bold format. The product overview is given at the start, succeeded by the complete detailed features, including both functional and non-functional requirements. The entire interfaces are also described. The SRS ends with appendices, including a glossary.

1.4 Product Scope

The project VSCrypt will help in general elections to be held fairly across the country. The project has five modules, registration module, authorization module, casting votes, counting votes and results module.The modules use blockchain approach and cryptography which encrypts the blocks using hashfunctionsproviding transparent system and securing the votes. The system will provide a registration process for everyvoter, casting and countingof votes.

1.5 References

1.5.1 IEEE Computer Society Conventions

- **Use Case Modeling Guidelines**, which documents the guidelines used to develop the use case model specifying the functional requirements in this specification. http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=787548

- **System Requirements Specification Content and Format Standard**, which specifies the content and format of this specification. http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?tp=&isnumber=15571&arnumber=720574&punumber=5841

- **System Requirements Specification Template**, which provides the skeleton for this specification. http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?tp=&isnumber=16016&arnumber=741940&punumber=5982

2 Existing System

Since its establishment in 1947, Pakistan has had an asymmetric federal government and is a federal parliamentary democratic republic. At the national level, the people of Pakistan elect a bicameral legislature, the Parliament of Pakistan. The parliament consists of a lower house called the National Assembly, which is elected directly, and an upper house called the Senate, whose members are chosen by elected provincial legislators.

The head of government, the Prime Minister, is elected by the majority members of the National Assembly and the head of state (and figure head), the President, is elected by the Electoral College, which consists of both houses of Parliament together with the four provincial assemblies(wikipedia n.d.).

The Election Commission of Pakistan, a constitutionally established institution chaired by an appointed and designated Chief Election Commissioner, supervises the general elections. The Pakistan Constitution defines (to a basic extent) how general elections are held in Part VIII, Chapter 2 and various amendments. A multi-party system is in effect, with the National Assembly consisting of 342 seats and the Senate consisting of 104 seats elected from the four provinces. By law, general elections must be held within two months of the National Assembly completing its term [1]. .

2.1 Electoral Constituencies:

- **National Assembly:** Directly elected (272 seats): Single-- member districts divided by province, the Federally Administered Tribal Areas, and the Federal Capital. The number of seats in each is defined in the constitution. Proportional representation: Women (60 seats): 4 multi-- member districts divided by province, with the number of seats in each defined in the constitution. Non-- Muslims (10 seats): One at- large constituency.

- **Senate:** Provincial Assemblies (88 seats): 4 constituencies corresponding to the Provincial Assemblies of the 4 provinces. National Assembly members from the territories (8 seats): One constituency of the members of the National Assembly from the Federally Administered Tribal Areas. Federal Capital (4 seats): One constituency of the National Assembly[1].

2.2 Voting Registration System:

- For the conduct of elections to the National and Provincial Assemblies, the Election Commission appoints a District Returning Officer for each District and a Returning Officer for each constituency, who are drawn from amongst the officers of the Judiciary, the Federal/Provincial Government and Local Authorities. Returning Officers are mostly Additional District & Sessions Judges.
- The list of polling stations is prepared by the Returning Officers(htt) and approved by the District Returning Officer(htt1). No polling station can be located in the premises of a candidate.
- The list of Presiding Officers(htt2), Assistant Presiding Officers and polling staff is prepared by the Returning Officer and sent to the District Returning Officer for approval at least 15 days before the polls. The Presiding Officer is responsible for conducting polls at the Polling Station and maintaining law and order, being assisted by the Assistant Presiding Officers and Polling Officer.
- After the publication of Election Schedule by the Election Commission, nomination papers are invited from interested contesting candidates.
- Scrutiny of nomination papers is carried out by the Returning Officers and nomination papers are accepted/rejected.
- Appeals against rejection/acceptance of nomination papers are filed with the appellate tribunal, who decide such appeals summarily within such time as may be notified by the Commission and any order passed thereon shall be final.
- Final list of contesting candidates is prepared and published in the prescribed manner by the Returning Officer after incorporation of the decisions on appeals and after withdrawal of candidature by the candidates if any.

- Election Symbols are also allocated to the candidates by the Returning Officer according to their party affiliation or as an individual candidate, from the list of Election Symbols approved by the Election Commission. The Returning Officer also publishes the names of the contesting candidates arranged in the Urdu alphabetical order specifying against each the symbol allocated to him.
- The Election Commission of Pakistan provides each Returning Officer with copies of voter's list for his constituency who distributes it amongst the Presiding Officers in accordance with the polling scheme and assignment of voters to each polling station/booth.
- Voters cast their votes at specified polling stations according to their names in an electoral rolls. Since the election for both National and Provincial Assemblies constituencies are held on the same day, the voter is issued two separate ballot papers for each National Assembly and Provincial Assembly constituency.
- When an elector presents himself at the polling station to vote, the Presiding Officer shall issue a ballot paper to the elector after satisfying himself about the identity of the elector through his identity card.
- Polling is held for nine hours on the polling day without any break.
- Immediately the poll votes are counted at the polling stations by the Presiding Officers in presence of the candidates, their Election Agents, and Polling Agents.
- After counting the votes, the Presiding Officer prepares a summary of the count indicating the number of votes secured by a candidate, and send it to the Returning Officer along with the election material, un-used ballot papers, spoilt ballot papers, tendered ballot papers, challenged ballot papers, marked copies of the electoral rolls, the counter-foils of used ballot papers, the tendered votes lists, and the challenged votes lists.
- The Presiding Officers also announce the result of count at the polling stations and paste a copy of the result outside the polling stations.
- After the receipt of statement of counts from the Presiding Officers of the polling stations, the Returning Officer compiles the preliminary unofficial result and intimates the results to the Election Commission through fax for announcement on print/electronic media.
- After the announcement of unofficial result, the Returning Officer serves a notice to all the contesting candidates and their election agents regarding the day, time and place fixed for consolidation of the result. In the presence of the contesting candidates and election agents, the Returning Officer consolidates the results of the count furnished by the Presiding Officers in the prescribed manner including postal ballot received by him before the polling day.

- Immediately after preparing the consolidated statement the Returning Officer submits a copy to the Election Commission in the prescribed form which publishes the names of the returned candidates in the official Gazette[2].

2.3 Roles and Responsibilities

2.3.1 Election Commission of Pakistan (ECP):

ECPis responsible for the following: issuing notification of the appointment of DROs AROs ROs,announcement of election program,assigning dates and time to various stages of elections,approval for making changes in the lists of presiding officers APO s Pos as well as in the list of polling station,appointment of appellate tribunals,names of returned candidates ,appointment of election tribunals,announcing the country wide election results allocation of election symbols to political parties and just managing the overall election process

2.3.2 Returning officer:

Reporting to the Chief Electoral Officer (CEO), the Returning Officer (RO) is responsible for the preparation and delivery of provincial electoral events in the electoral district to which they are appointed Returning officers are accountable for the following
Acquiring and maintaining the knowledge, skills, and abilities required to effectively perform their duties, Overseeing voter registration and enumeration in their electoral district, Administering elections, by-elections, and plebiscites within the electoral district, Managing the financial, administrative, and human resources required for the administrative conduct of elections, Communicating information to the public, candidates, political parties and Elections Nova Scotia, Carrying out related administrative duties in accordance with general or specific instructions issued by the CEO, Being an effective and non-partisan representative of Elections Nova Scotia, Contributing to the improvement of the electoral process

2.3.3 Presiding officer:

Presiding Officers are responsible for the conduct of the ballot in the polling stations and they must have a good knowledge of the voting procedures. Presiding officer has the following duties;comply with any instructions from the Returning Officer, take charge of a polling station, ensure that all electors are treated impartially and with respect, maintain the secrecy of the ballot, supervise the Poll Clerk(s) at the polling station

3. Overall Description

VSCrypt is basically a securee-voting system using blockchain to resolve currentissuesrelating to the elections in the country. It basically uses the current system hierarchy and administrativeauthorties and impliesthemintoanelectronic system insteadof manual entries. It uses decentralized architecture integrated with blockchain and cryptographic algorithms ensuring transparency, security, authorization and privacy for the democratic elections being held in the country.Inspiteoftraditionalballot system, our system providessecureelectronicvoting. The blockchain structure is append-only data structure, i.e new blocks canbeaddedbutcannotbeammended, deletedorcreated, in such a waythateveryblockhas a hashof the functionlinked to the previousblock. The mainfeaturesof the system includes Registeration, Voting, Verification, Counting and Recounting.

3.1 Product Functions

- Each person can vote only once with “valid identity” authorized by controlling authority.
- An election system should ensure and proof to a voter, that the voters vote, was counted, and counted correctly.
- The anonymous registration list and anonymous election results are on bockchain.
- PrePolling: Citizens can vote before elections to give their opinion about the candidates.
- The entire system is independent of any government or agency.
- Once vote casted, all ballots will be supervised by authorized officer.

3.2 Key Concepts

- Controlling authority is the organization that authenticates voters and provides them with a voting token.
- A Ballot token is a unique public key generated by the secure e-voting system which enables him to cast a ballot anonymously.
- A ballot in this system can be any digital asset such as a picture or a form. It is signed by the voter using ballot token.
- The registration log is a blockchain with all the registered voters but does not have identifying information of the voter.
- The ballot log is a blockchain of all the casted votes in an election.
- The system provides easy ways for voters to validate that their vote is un-tampered.

3.3 Product Techniques

- Cryptographic approach insures the anonymity of the votes.
- It detects the malicious votes using two factor authentication.

3.4 System Hierarchy

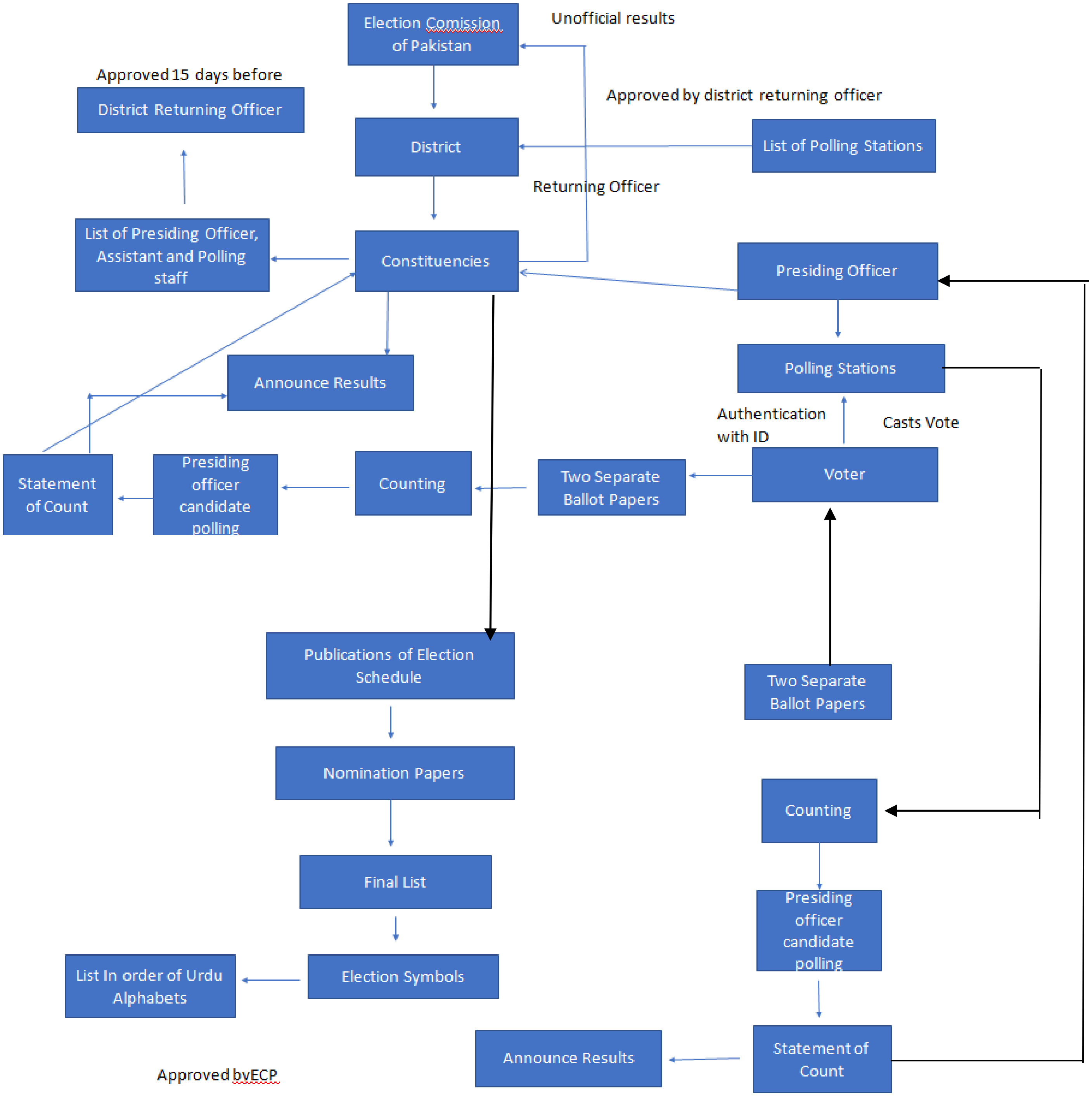

Election Comission of Pakistan
Unofficial results
Approved 15 days before
District Returning Officer
District
Approved by district returning officer
List of Polling Stations
Returning Officer
List of Presiding Officer, Assistant and Polling staff
Constituencies
Presiding Officer
Polling Stations
Announce Results
Authentication with ID
Casts Vote
Statement of Count
Presiding officer candidate polling
Counting
Two Separate Ballot Papers
Voter
Publications of Election Schedule
Two Separate Ballot Papers
Nomination Papers
Counting
Final List
Presiding officer candidate polling
List In order of Urdu Alphabets
Election Symbols
Announce Results
Statement of Count
Approved bvECP

Figure 1 - System Hierarchy

3.5 User Classes and Characteristics

3.5.1 Summary of User Classes

The following section describes the types of users of the VSCrypt. There are explanations of the user followed by the interactions the user(s) shall be able to make with the software.

3.5.1.1 User who Intend to Cast Vote

The user in this is basically the voter who wants to cast vote. The user should be able to register himself as the authorized voter, gets the ballot paper and casts his vote successfully which is then counted and provides end results.

3.6 Operating Environment

3.6.1 Hardware

VSCrypt operates, either directly or indirectly, with the following external hardware:

- **Computer/ Smartphone**: The user uses a computer or a smartphone to cast his vote.

3.6.2 Software

- Truffle
- Node js
- Metamask
- Visual studio code

3.7 Design and Implementation Constraints

- VSCrypt will enable a user to register himself.
- The system then authorizes a valid user.
- For a valid user, a voting token is assigned through which a user asks for the ballot paper.
- The system then checks whether the ballot paper has been provided before on the same voting token or not ensuring proof of authority.
- If not, then it asks for a security question ensuring two way authentication.
- The authenticated user then gets the ballot paper and casts his vote.
- The casted vote generates a hash function which then adds its node to the existing blockchain verifying the valid hash of the block and counts the vote ensuring proof of work.

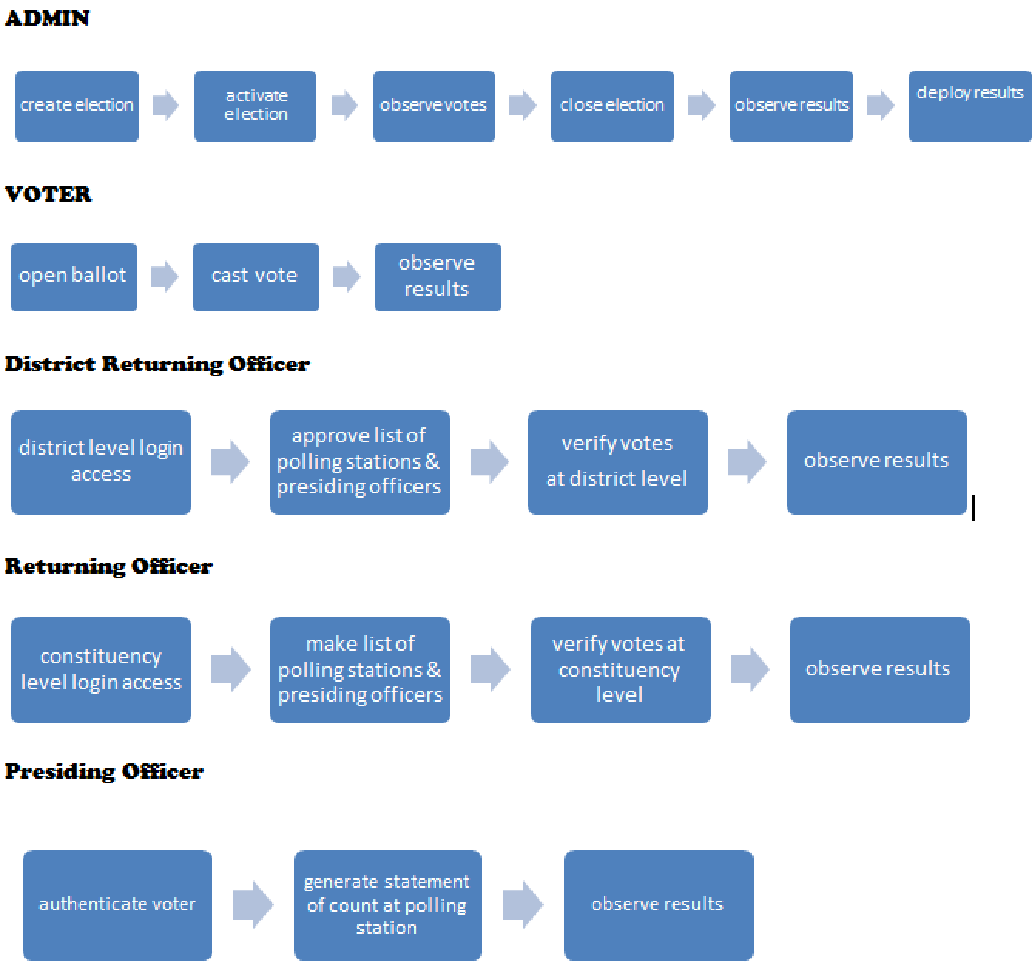

ADMIN
create election
activate election
observe votes
close election
observe results
deploy results
VOTER
open ballot
cast vote
observe results
District Returning Officer
district level login access
approve list of polling stations & presiding officers
verify votes at district level
observe results
Returning Officer
constituency level login access
make list of polling stations & presiding officers
verify votes at constituency level
observe results
Presiding Officer
authenticate voter
generate statement of count at polling station
observe results

Figure 2 - Administration Duties

ELECTION ROLES AND PROCESS

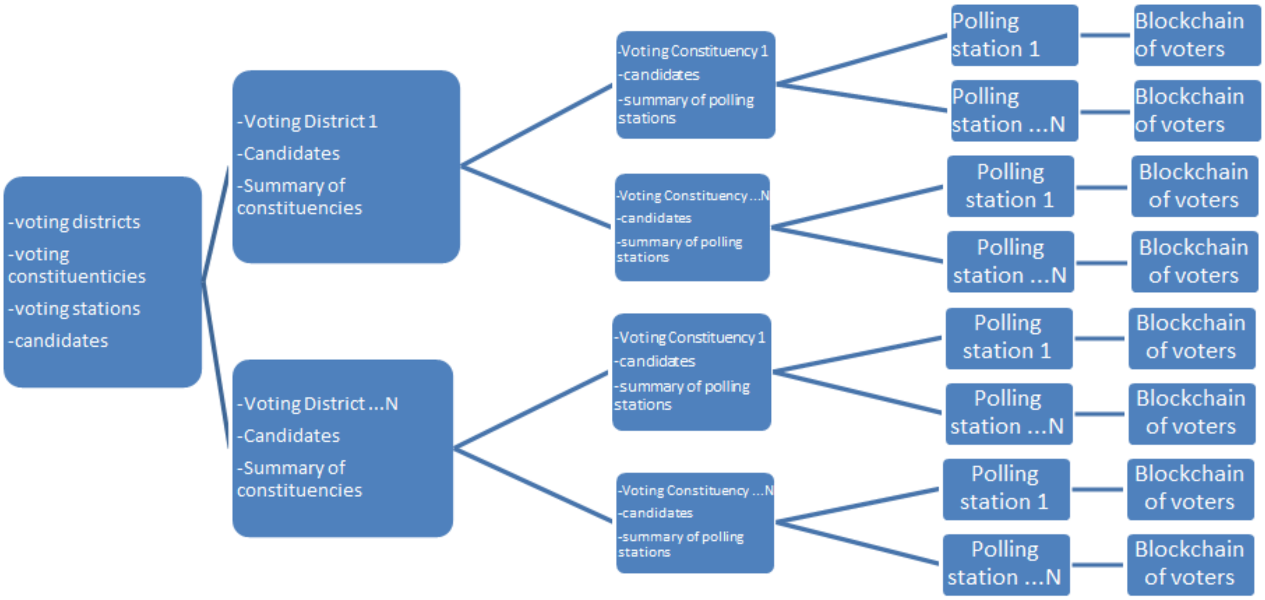


Figure 3 - Election Process

ELECTION AS A SMART CONTRACT

3.8 User Documentation

Following are the guides for the user of VSCrypt: -

- Usage manuals with pictures and text for using the system

3.9 Functional Requirements

- System shall be able to register the voter and authenticate the eligible voters.
- The system shall provide the ballot papers to the eligible voter only once.
- The system shall be able to count the casted vote against each candidate.
- The system shall generate end results.

3.10 System Features

- Voter Registration
- Voter Authentication
- Assigning ballot paper
- Two-way authentication
- Registering vote

3.10.1 Voter Registration

Description

This feature enables the user to register himself/herself for casting the vote.

Stimulus/Response Sequences

Stimulus/Response Sequences

3.10.1.1 Voter Registration
Preconditions • The user enters the required data.
Interactions • The entered data saves into the database.
Post conditions • User registers as an authenticated user
Categorization • **Criticality**: Medium • **Probability of Defects**: Medium • **Risk**: Low

Table i - Voter Registration

3.10.2 Voter Authentication

Description

This feature authenticates whether the user registered is an eligible voter or not.

Stimulus/Response Sequences

3.10.2.1 Eligible Voter
Preconditions • The system gets the data of the registered user.
Interactions • The data matches the eligibility criteria of the voter.
Post conditions • User is registered as an authenticated user.
Categorization • **Criticality**: Medium • **Probability of Defects**: Medium • **Risk**: Medium

Table ii - Voter Authentication

3.10.2.2 Not Eligible Voter

Preconditions

- The system gets the data of the registered user.

Interactions

- The data matches the eligibility criteria of the voter.

Post conditions

- User is not eligible for voting.

Categorization

- **Criticality**: Medium
- **Probability of Defects**: Medium
- **Risk**: Medium

Table iii - Not Eligible Voter

3.10.3 Assigning Ballot Paper

Description

This feature provides the ballot paper to the eligible voter only once.

Stimulus/Response Sequences

3.10.3.1 Providing Ballot Paper

Preconditions

- The system checks the ballot paper is not assigned to the same voter before.

Post conditions

- Ballot paper is provided to vote.

Categorization

- **Criticality**: Medium
- **Probability of Defects**: Medium
- **Risk**: Medium

3.10.3.2 *Table - Providing Ballot Paper*

3.10.3.2 No Ballot Paper

Preconditions

- The system checks the ballot paper is assigned to the same voter before.

Post conditions

- Ballot Paper is not provided.

Categorization

- **Criticality**: Medium
- **Probability of Defects**: Medium

• **Risk**: Medium

Table iv - No Ballot Paper

3.10.4 Two-Way Authentication

Description

This feature authenticates that the registered user is casting vote himself.

Stimulus/Response Sequences

3.10.4.1 Providing access to vote
Preconditions • The system checks the security question asked/matches the answer.
Post conditions • Providing access to vote.
Categorization • **Criticality**: Medium • **Probability of Defects**: Medium • **Risk**: Medium

Table v - Providing access to vote

3.10.4.2 No Access to vote
Preconditions • The system checks the security question asked does not match the answer.
Post conditions • No access to vote.
Categorization • **Criticality**: Medium • **Probability of Defects**: Medium • **Risk**: Medium

Table vi - No access to vote

3.10.5 Registering Vote

Description

This feature registers the casted vote and counts the votes..

Stimulus/Response Sequences

3.10.5.1 Vote Registered

Preconditions

- The system checks that the casted vote has no ambiguity.

Post conditions

- Registers vote.

Categorization

- **Criticality**: High
- **Probability of Defects**: High
- **Risk**: Medium

Table vii - Vote Registered

3.10.5.2 Vote not registered

Preconditions

- The system checks that the casted vote has ambiguity.

Post conditions

- Vote discarded.

Categorization

- **Criticality**: High
- **Probability of Defects**: High
- **Risk**: Medium

Table viii - Vote not Registered

3.11 Non-Functional Requirements

3.11.1 Performance Requirements

Reliability

- Reliability is defined as providing the user up to date, correct information when they need it.

Security

- System shall be secure enough not to breach any security.

Legal

- System should follow customer privacy policy strictly.

Efficient

- The system will authenticate the valid users and valid votes.

Transparent

- The system provides a transparent system of elections with no rigging.

3.11.2 Safety Requirements

- Information shall be safely and securely transmitted between the blocks with no changes.

3.11.3 Security Requirements

- The system shall provide a secure environment to the user for casting their votes anonymously.

3.12 Software Quality Attributes

3.12.1 Usability

The graphical user interface of system is to be designed with usability as the priority. The app will be presented and organized in a manner that is both visually appealing and easy to use for every individual.

3.12.2 Accuracy

To ensure reliability and correctness, there will be zero tolerance for errors in the algorithm that computes results.

3.12.3 Legal

The system shall follow customer privacy policy.

3.12.4 Transparency

The system shall provide transparency and will cause no misunderstandings between the government, candidates and public.

3.12.5 Ease of Use

The system will be easy to use by every individual so that anyone can cast their vote without any hesitation.

3.13 Work Breakdown Structure

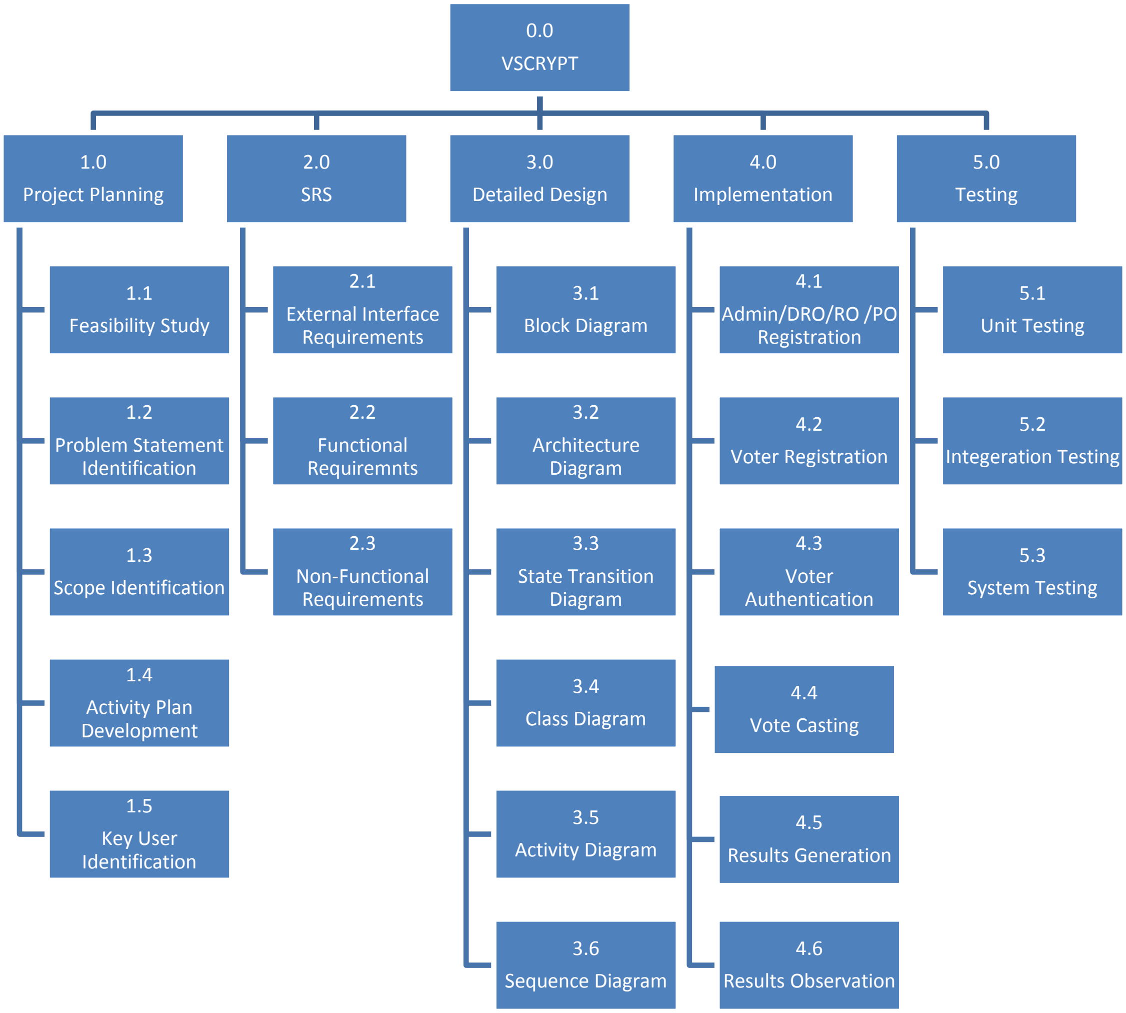


Figure 4 - Work Break Down Structure

4. System Architecture Description

This section provides detailed system architecture of VSCRYPT. Overview of system modules, their structure and relationships are described in this section. User interfaces and related issues are also discussed.

4.1 Overview of Modules

VSCRYPT requires several modules to work. Following is the brief overview of all these modules. Detailed descriptions of these modules are presented in section 3.

1. Admin/DRO/RO/PO registration Module:

This module registers the admin, district returning officer returning officer and presiding officer for carrying out the election process from creating, activating, generating ,displaying results.

2. **Voter Registration/Authentication Module**

   This module registers the voter and authenticates it whether he/she are allowed to vote or not.

3. **Vote Casting Module**

   This module allows the authenticated voter to cast vote.

4. **Results Generation/Observation Module**

   This module generates the results which is validated and computed by PO,RO,DRO and admin at each hierarchy level

5. **Database/Blockchain Module**

   This module will save the voting results in encrypted form on a node in blockchain which acts as a database

4.2 Structure and Relationships

This section covers the overall technical description of VSCRYPT. It shows the working of application in perspective of different viewpoints and shows relationships between different components.

4.2.1 System Block Diagram

This diagram shows the higher-level description of the application. It shows all the modules of the system and their associations and flow of data between modules.

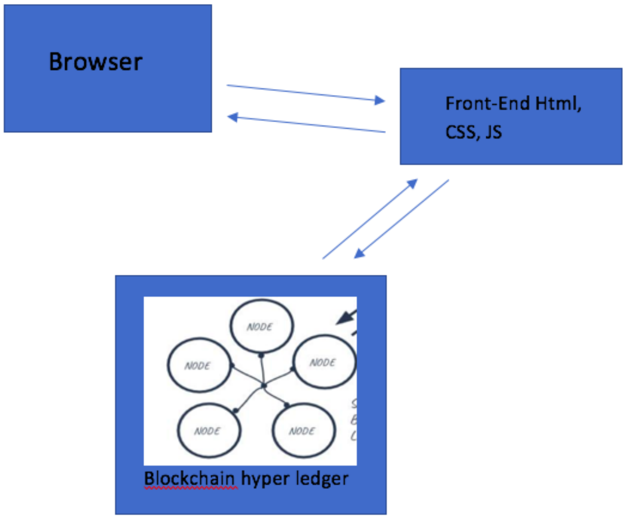


Figure 5 - System Block Diagram

User through the browser access the e-voting system in which we will have a traditional front-end client that is written in HTML, CSS, and Javascript. Instead of talking to a back-end server, this client will connect to a local Ethereum blockchain that we'll install. We'll code all the business logic about our dApp in an Election smart contract with the Solidity programming language. We'll deploy this smart contract to our local Etherum blockchain, and allow accounts to start voting.

4.2.2 User View (Use case diagram)

Following diagram shows course of events that take place when an actor (user and other allowed interactions) interacts with system.

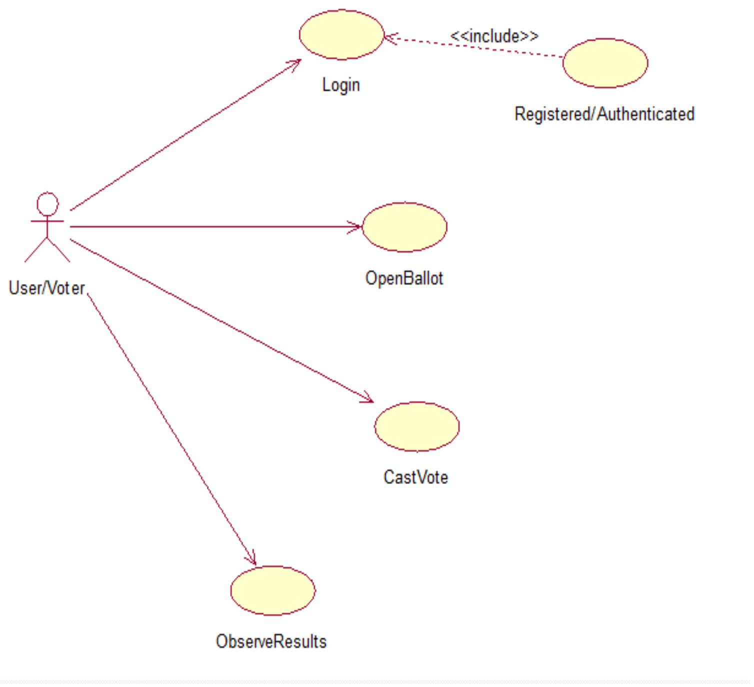


Figure 6 - user/voter-use case diagram

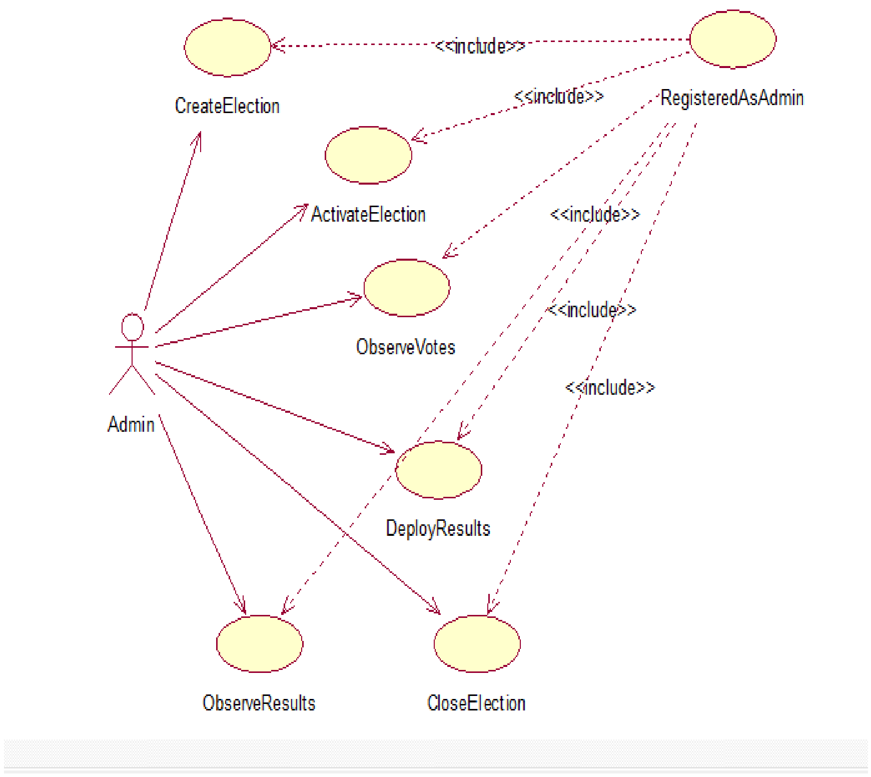


Figure 7 - admin-use case diagram

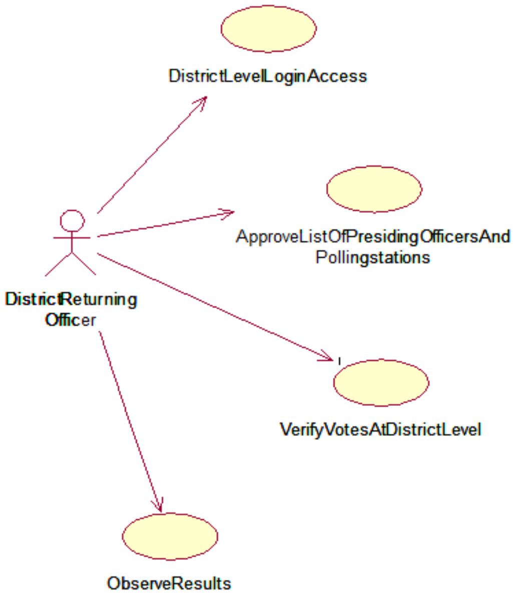


Figure 8 - DRO-use case diagram

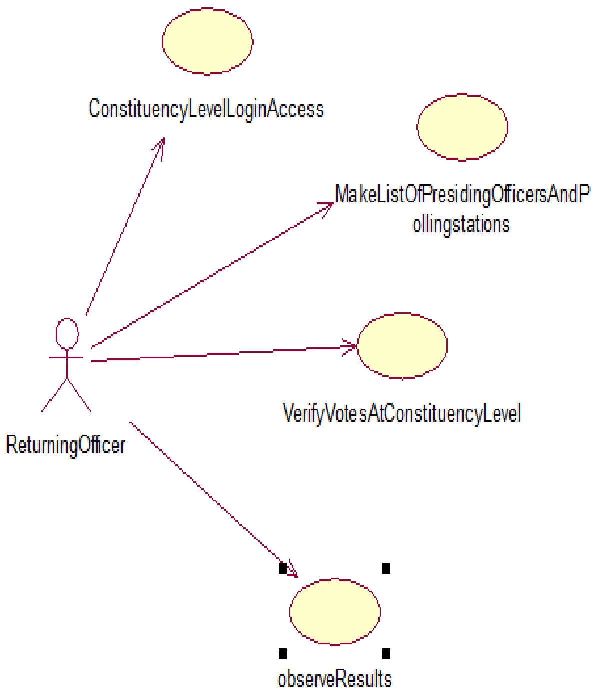

ConstituencyLevelLoginAccess
MakeListOfPresidingOfficersAndPollingstations
VerifyVotesAtConstituencyLevel
ReturningOfficer
observeResults

Figure 9 - RO-use case diagram

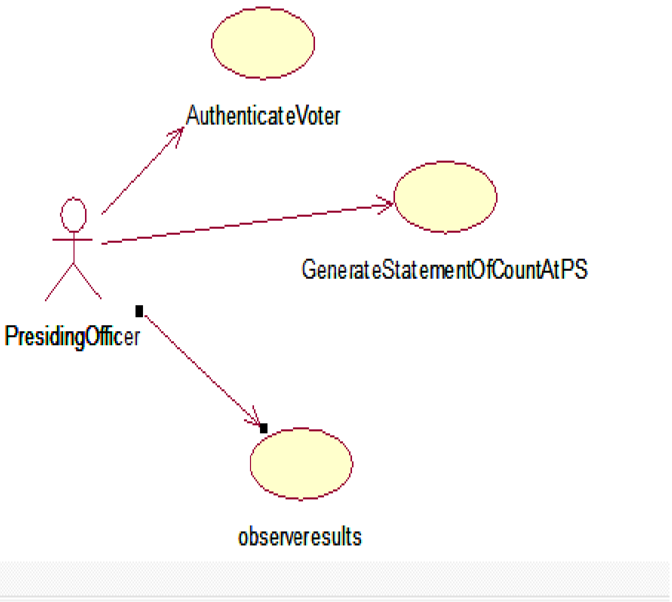


Figure 10 - PO-use case diagram

Use Cases:

Use Case 1

Use case name	login
Primary actor	User/voter
Secondary actor	N/A
Normal course	Admin after logging in creates election, activate it and let users/voters vote
Alternate course	If the user is not authenticated while registering means he is not eligible to vote ,then login fails and he is unable to cast vote
Pre-condition	User must be eligible
Post-condition	User must be provided with ballot paper so that he can vote his selected candidate
Extend	N/A
Include	User must be registered /authenticated
Assumptions	The system's server never gets down and it is user friendly

Table ix - Use case Login

Use Case 2

Use case name	Open ballot
Primary actor	User/voter
Secondary actor	N/A
Normal course	After logging in the voter/user is provided with the ballot paper on which he/she marks their selected candidate and cast vote and observe results thereafter until elections are over
Alternate course	If the user is not authenticated while registering means he is not eligible to vote ,then login fails and he is unable to cast vote
Pre-condition	User must log in
Post-condition	After selecting the candidate on ballot paper user must be displayed cast vote button

Extend	N/A
Include	N/A
Assumptions	The system’s server never gets down and it is user friendly

Table x - USe case Open Ballot

Use Case 3

Use case name	Cast vote
Primary actor	User/voter
Secondary actor	N/A
Normal course	After logging in the voter/user is provided with the ballot paper on which he/she marks their selected candidate and cast vote and observe results thereafter until elections are over
Alternate course	If the user is not authenticated while registering means he is not eligible to vote ,then login fails and he is unable to cast vote
Pre-condition	User must be provided with the ballot paper
Post-condition	User must be able to observe results
Extend	N/A
Include	N/A
Assumptions	The system’s server never gets down and it is user friendly

Table xi - Use case Cast Vote

Use Case 4

Use case name	Observe results
Primary actor	User/voter
Secondary actor	N/A
Normal course	After logging in the voter/user is provided with the ballot paper on which he/she marks their selected candidate and cast vote and observe results thereafter until elections are over
Alternate course	If the user is not authenticated while registering means he is not eligible to vote ,then login fails and he is unable to cast vote
Pre-condition	User’s vote must be casted/registered
Post-condition	User must be displayed final results

Extend	N/A
Include	N/A
Assumptions	The system’s server never gets down and it is user friendly

Table xii - Use case Observe Results

Use Case 5

Use case name	Create elections
Primary actor	admin
Secondary actor	N/A
Normal course	Admin after logging in creates elections activate it and lets users/voters vote ,observes results put them together ,after fixed time closes the elections and display the final results
Alternate course	If admin is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	Admin must log in
Post-condition	After creating elections admin must be displayed the option of activating it
Extend	N/A
Include	Must be registered as an admin
Assumptions	The system’s server never gets down and it is user friendly

Table xiii - Use case Create Elections

Use Case 6

Use case name	Activate elections
Primary actor	admin
Secondary actor	N/A
Normal course	Admin after logging in creates elections activate it and lets users/voters vote ,observes results put them together ,after fixed time closes the elections and display the final results
Alternate course	If admin is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	Admin must create elections

Post-condition	Admin must be able to observe votes
Extend	N/A
Include	Must be registered as an admin
Assumptions	The system’s server never gets down and it is user friendly

Table xiv - Use case Activate Elections

Use Case 7

Use case name	Observe votes
Primary actor	admin
Secondary actor	N/A
Normal course	Admin after logging in creates elections activate it and lets users/voters vote ,observes results put them together ,after fixed time closes the elections and display the final results
Alternate course	If admin is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	Admin must activate elections
Post-condition	Admin must be able to deploy results
Extend	N/A
Include	Must be registered as an admin
Assumptions	The system’s server never gets down and it is user friendly

Table xv - Use case Observe Votes

Use Case 8

Use case name	Observe votes
Primary actor	admin
Secondary actor	N/A
Normal course	Admin after logging in creates elections activate it and lets users/voters vote ,observes results put them together ,after fixed time closes the elections and display the final results
Alternate course	If admin is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	Admin must activate elections

Post-condition	Admin must be able to deploy results
Extend	N/A
Include	Must be registered as an admin
Assumptions	The system’s server never gets down and it is user friendly

Table xvi - Use case Observe Votes

Use Case 9

Use case name	Deploy results
Primary actor	admin
Secondary actor	N/A
Normal course	Admin after logging in creates elections activate it and lets users/voters vote ,observes results put them together ,after fixed time closes the elections and display the final results
Alternate course	If admin is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	Admin must be able to observe votes
Post-condition	After deploying admin must be able to close elections
Extend	N/A
Include	Must be registered as an admin
Assumptions	The system’s server never gets down and it is user friendly

Table xvii - Use case Deploy Results

Use Case 10

Use case name	Close elections
Primary actor	admin
Secondary actor	N/A
Normal course	Admin after logging in creates elections activate it and lets users/voters vote ,observes results put them together ,after fixed time closes the elections and display the final results
Alternate course	If admin is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	Admin must be able to deploy results

Post-condition	Admin must be able to observe and display results
Extend	N/A
Include	Must be registered as an admin
Assumptions	The system’s server never gets down and it is user friendly

Table xviii - - Use case Close Elections

Use Case 11

Use case name	Observe results
Primary actor	admin
Secondary actor	N/A
Normal course	Admin after logging in creates elections activate it and lets users/voters vote ,observes results put them together ,after fixed time closes the elections and display the final results
Alternate course	If admin is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	Admin must be able to close elections
Post-condition	Admin must be able to display results
Extend	N/A
Include	Must be registered as an admin
Assumptions	The system’s server never gets down and it is user friendly

Table xix- Use case Observe Results

Use Case 12

Use case name	District level login access
Primary actor	District returning officer
Secondary actor	N/A
Normal course	DRO after logging in as the district returning officer approves the list of presiding officers and polling stations provided by returning officer,then verify votes at district level and observe results
Alternate course	If DRO is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions

Pre-condition	DRO must be registered
Post-condition	DRO must be able to approve list of presiding officer and polling stations
Extend	N/A
Include	Must be registered as an DRO
Assumptions	The system's server never gets down and it is user friendly

Table xx- Use case District Level Login Access

Use Case 13

Use case name	District level login access
Primary actor	District returning officer
Secondary actor	N/A
Normal course	DRO after logging in as the district returning officer approves the list of presiding officers and polling stations provided by returning officer,then verify votes at district level and observe results
Alternate course	If DRO is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	DRO must be registered
Post-condition	DRO must be able to approve list of presiding officer and polling stations
Extend	N/A
Include	Must be registered as an DRO
Assumptions	The system's server never gets down and it is user friendly

Table xxi- Use case District Level Login Access

Use Case 14

Use case name	Approve list of presiding officer and polling stations
Primary actor	District returning officer
Secondary actor	N/A
Normal course	DRO after logging in as the district returning officer approves the list of presiding officers and polling stations provided by returning officer,then verify votes at district level and observe

	results
Alternate course	If DRO is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	DRO must log in
Post-condition	DRO must be able to verify votes at district level
Extend	N/A
Include	Must be registered as an DRO
Assumptions	The system's server never gets down and it is user friendly

Table xxii- Use case Approve PO

Use Case 15

Use case name	Verify votes at district level
Primary actor	District returning officer
Secondary actor	N/A
Normal course	DRO after logging in as the district returning officer approves the list of presiding officers and polling stations provided by returning officer,then verify votes at district level and observe results
Alternate course	If DRO is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	DRO must approve list of presiding officer and polling station
Post-condition	DRO must be able to observe results
Extend	N/A
Include	Must be registered as an DRO
Assumptions	The system's server never gets down and it is user friendly

Table xxiii- Use case Verify Votes at District Level

Use Case 16

Use case name	Constituency level login access
Primary actor	returning officer
Secondary actor	N/A
Normal course	RO after logging in as RO prepares list of presiding officer and

	polling station gets it verified by district returning officer and then verifies votes at constituency level
Alternate course	If RO is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	RO must be registered
Post-condition	DRO must be able to prepare list of presiding officer and polling stations
Extend	N/A
Include	Must be registered as an RO
Assumptions	The system's server never gets down and it is user friendly

Table xxiv- Use case Constituency level login access

Use Case 17

Use case name	Make list of presiding officer and polling station
Primary actor	returning officer
Secondary actor	N/A
Normal course	RO after logging in as RO prepares list of presiding officer and polling station gets it verified by district returning officer and then verifies votes at constituency level
Alternate course	If RO is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	RO must login as returning officer
Post-condition	DRO must be able to verify votes at constituency level
Extend	N/A
Include	Must be registered as an RO
Assumptions	The system's server never gets down and it is user friendly

Table xxv- Use case List of POs

Use Case 18

Use case name	Verify votes at constituency level
Primary actor	returning officer
Secondary actor	N/A

Normal course	RO after logging in as RO prepares list of presiding officer and polling station gets it verified by district returning officer and then verifies votes at constituency level
Alternate course	If RO is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	RO must prepare list of presiding officer and polling station
Post-condition	RO must be able to observe results
Extend	N/A
Include	Must be registered as an RO
Assumptions	The system's server never gets down and it is user friendly

Table xxvi- Use case Verify VOtes at Constituency Level

Use Case 19

Use case name	Authenticate voter
Primary actor	Presiding officer
Secondary actor	N/A
Normal course	Presiding officer after log in authenticates voter through their valid CNIC ,prepares statement of count at its polling station and forwards to returning officer
Alternate course	If PO is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	PO must login as presiding officer
Post-condition	PO must be able to present statement of count
Extend	N/A
Include	Must be registered as an PO
Assumptions	The system's server never gets down and it is user friendly

Table xxvii- Use case Authenticate Voter

Use Case 20

Use case name	Generates statement of count
Primary actor	Presiding officer
Secondary actor	N/A

Normal course	Presiding officer after log in authenticates voter through their valid CNIC ,prepares statement of count at its polling station and forwards to returning officer
Alternate course	If PO is not authenticated i.e. his record is not stored in database then he is unable to log in and perform its functions
Pre-condition	PO must verify voters
Post-condition	PO must be able to observe results
Extend	N/A
Include	Must be registered as an PO
Assumptions	The system’s server never gets down and it is user friendly

Table xxviii- Use case General Statement of count

4.2.3 Sequence Diagram

Following sequence diagrams show the sequence of activities performed in all use cases of the user described above

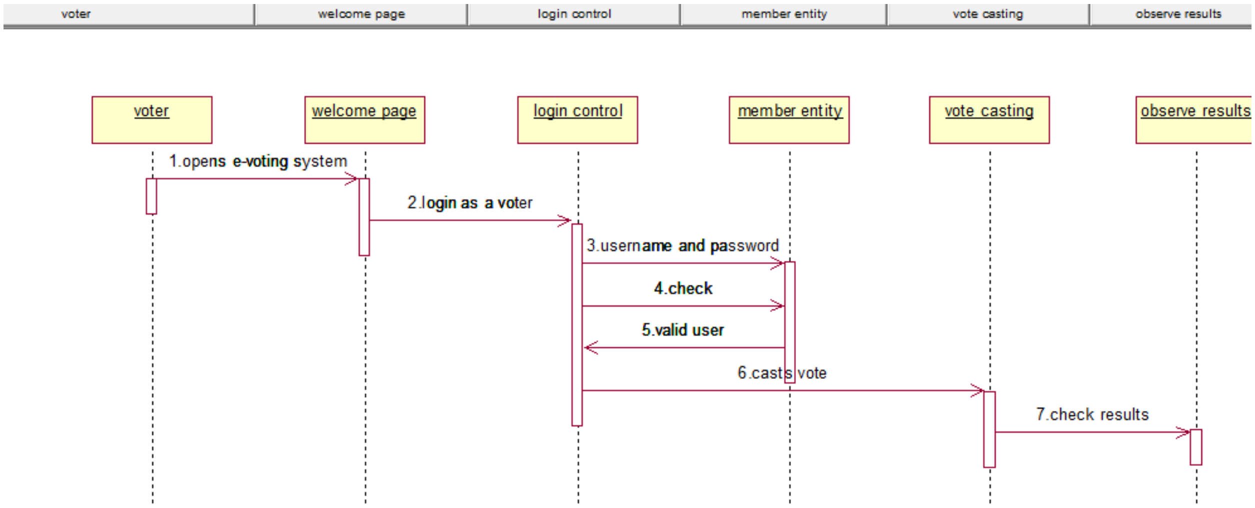


Figure 11 - Sequence Diagram(User)VSCRYPT

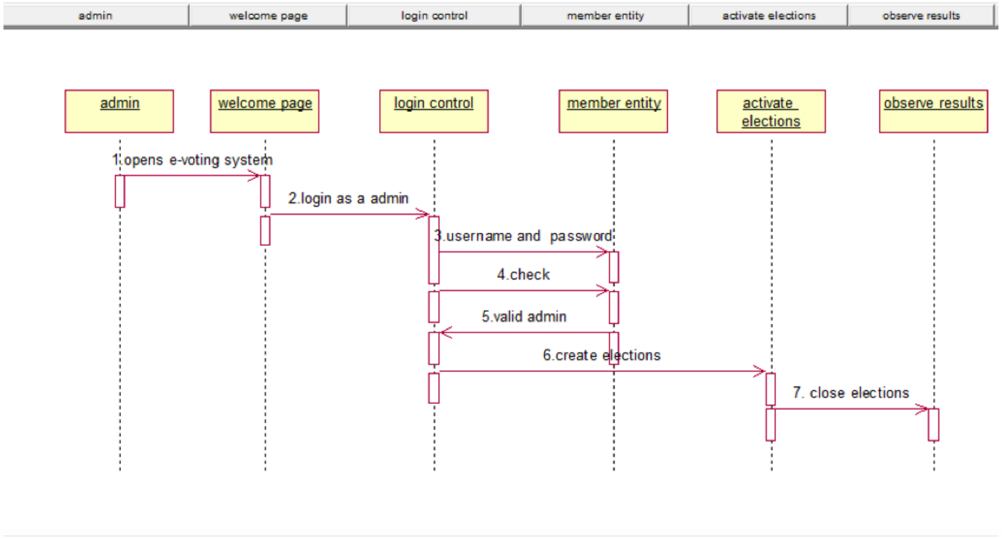


Figure 12 - Sequence Diagram(Admin) VSCRYPT

4.2.4 Implementation View (Class Diagram)

Class diagram shows all the classes of system and their relationship with one another. Following is the class diagram by following the MVC design pattern to implement event driven

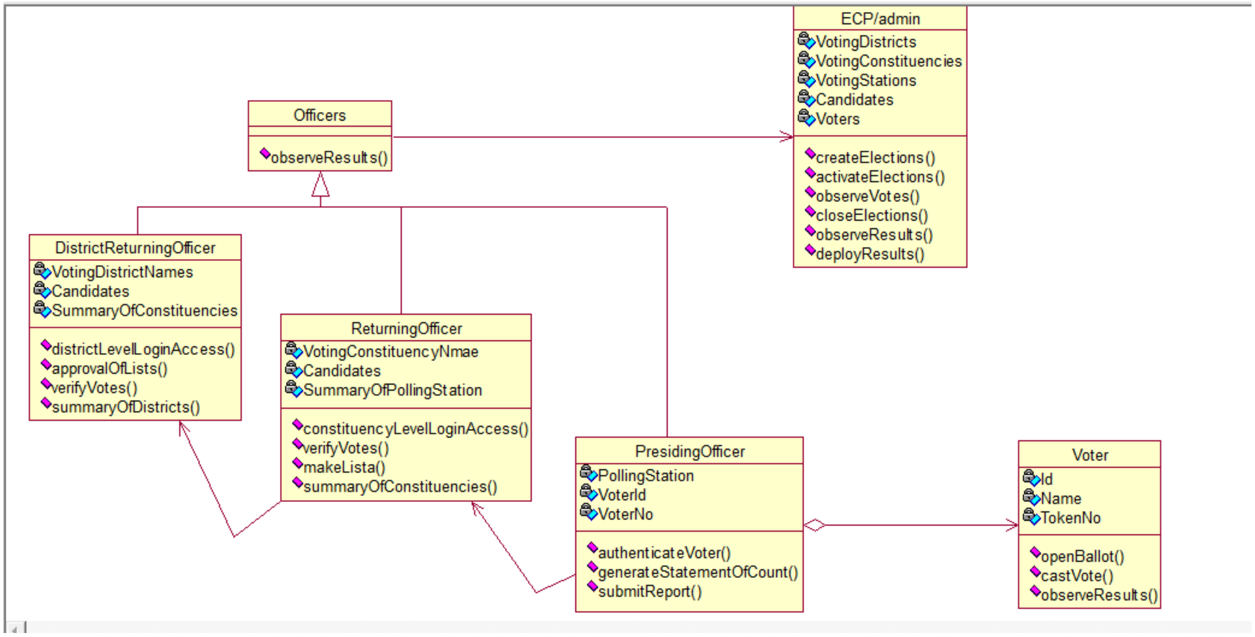


Figure 13 - Class Diagram- Roles and Responsibilities

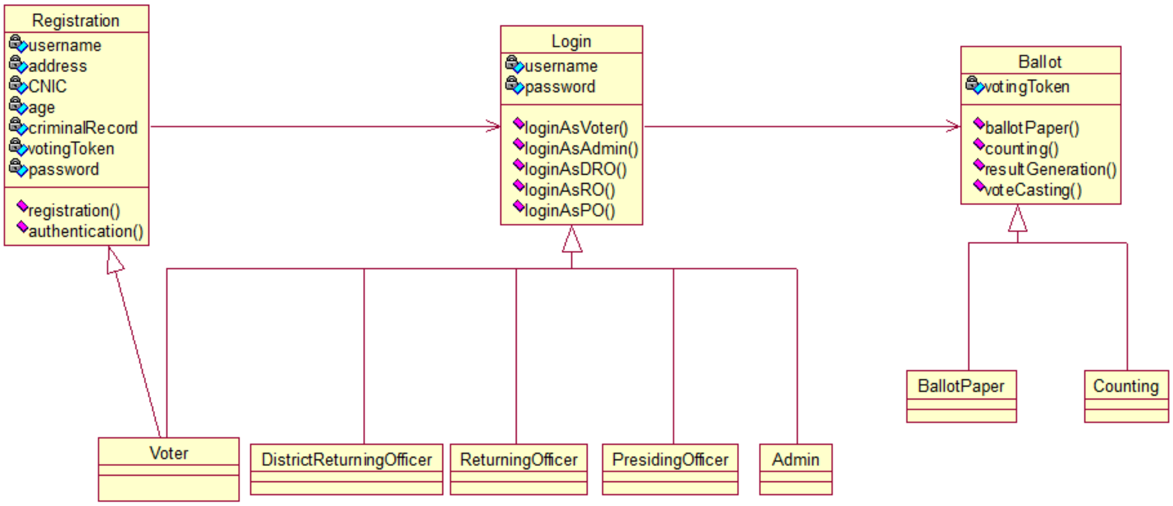


Figure 14 - Class Diagram VSCRYPT

4.2.5 Dynamic View (Activity Diagram)

In activity diagram, the dynamic view of the system is shown. All the activities are shown concurrently with their respective start and end states.

Class	Description
Registration	This class takes username, password, address, CNIC and registers the user and then authenticates him and if he is authenticated then generates a voting token
Login	This class lets user, admin, DRO, RO PO login by providing their username and password
Ballot	This class based on the voting token validates the user if valid then provides ballot paper let the user cast vote, count the votes and generate results

Voter	This class is inheriting registration class for voter registration and authentication and login class for logging in as a authenticated voter
DistrictReturningOfficer	This class is inheriting login class and lets user login as DRO
ReturningOfficer	This class is inheriting login class and lets user login as RO.
PresidingOfficer	This class is inheriting login class and lets user login as PO
Admin	This class is inheriting login class and lets user login as an admin
BallotPaper	This class is inheriting the ballot class and its main function is to provide user the ballot paper
Counting	This class is also inheriting ballot class for providing the functionality of counting the casted votes

Table xxix - Activity Diagram Description

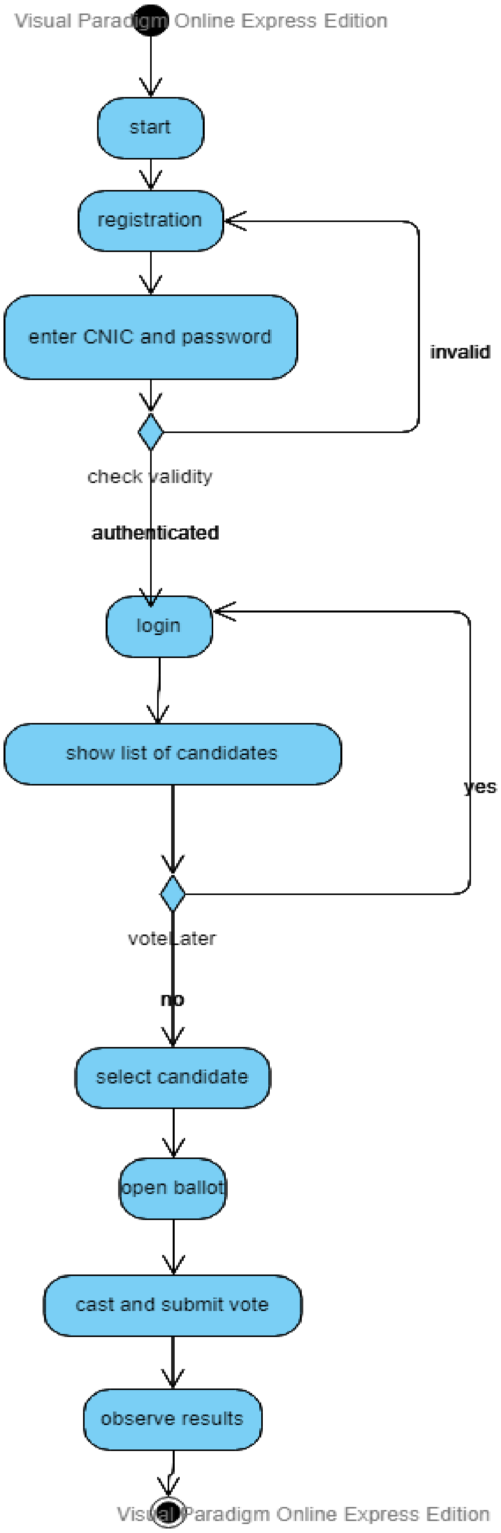


Figure 15 - Activity Diagram – User/Voter

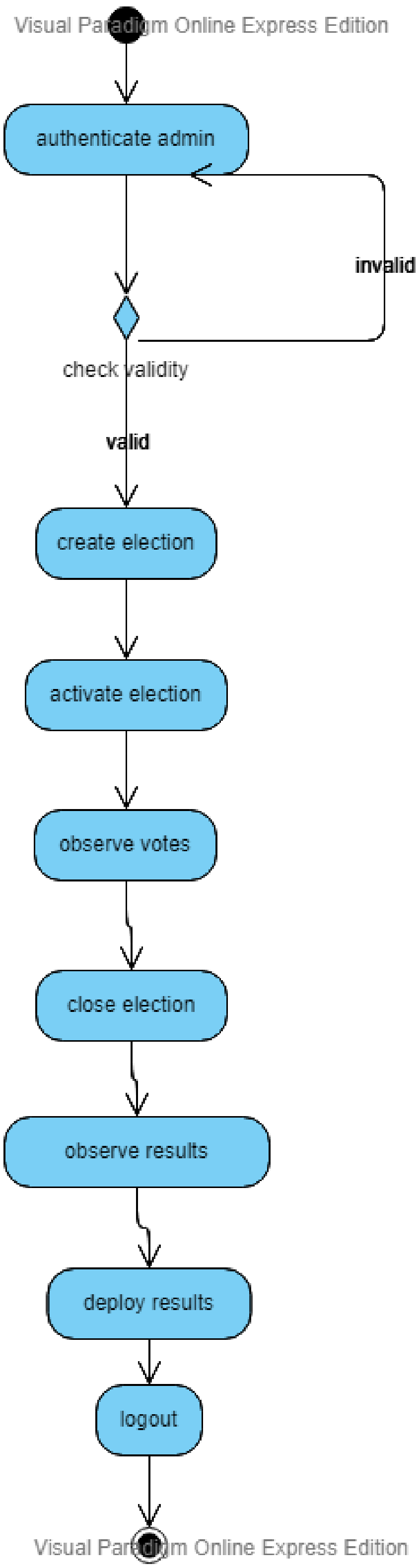


Figure 16 - Activity Diagram – Admin

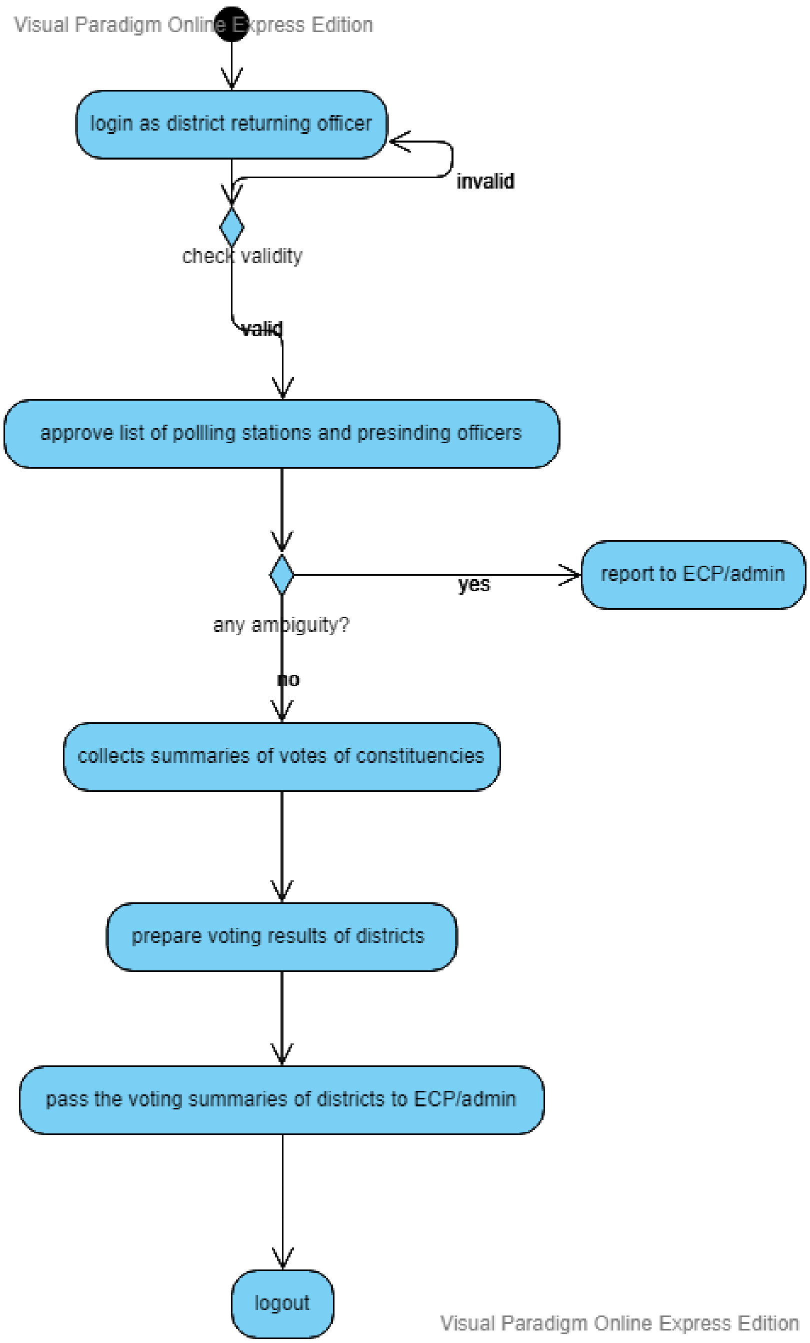

Visual Paradigm Online Express Edition
login as district returning officer
invalid
check validity
valid
approve list of pollling stations and presinding officers
yes
report to ECP/admin
any ambiguity?
no
collects summaries of votes of constituencies
prepare voting results of districts
pass the voting summaries of districts to ECP/admin
logout
Visual Paradigm Online Express Edition

Figure 17 - Activity Diagram – District Returning Officer

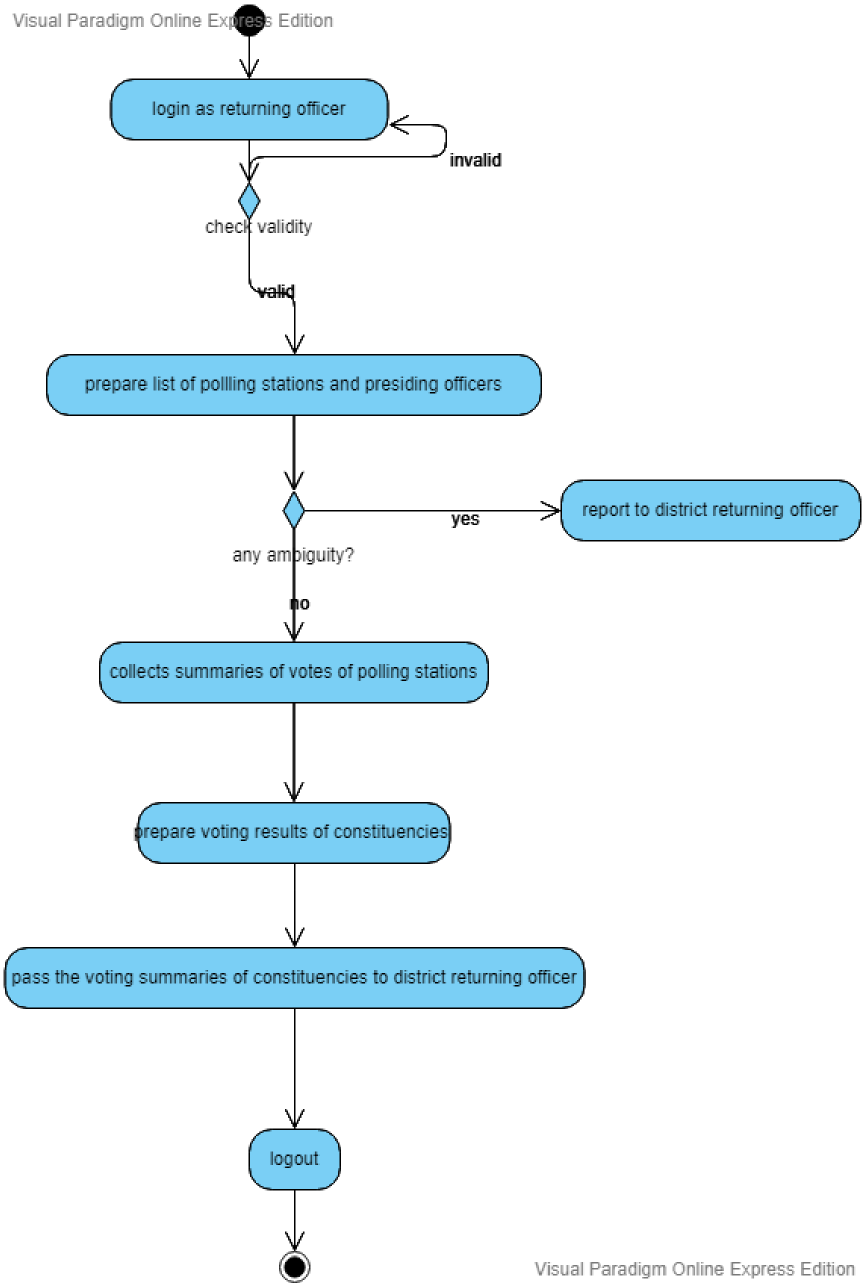

Visual Paradigm Online Express Edition
login as returning officer
invalid
check validity
valid
prepare list of pollling stations and presiding officers
yes
report to district returning officer
any ambiguity?
no
collects summaries of votes of polling stations
prepare voting results of constituencies
pass the voting summaries of constituencies to district returning officer
logout
Visual Paradigm Online Express Edition

Figure 18 - Activity Diagram – Returning Officer

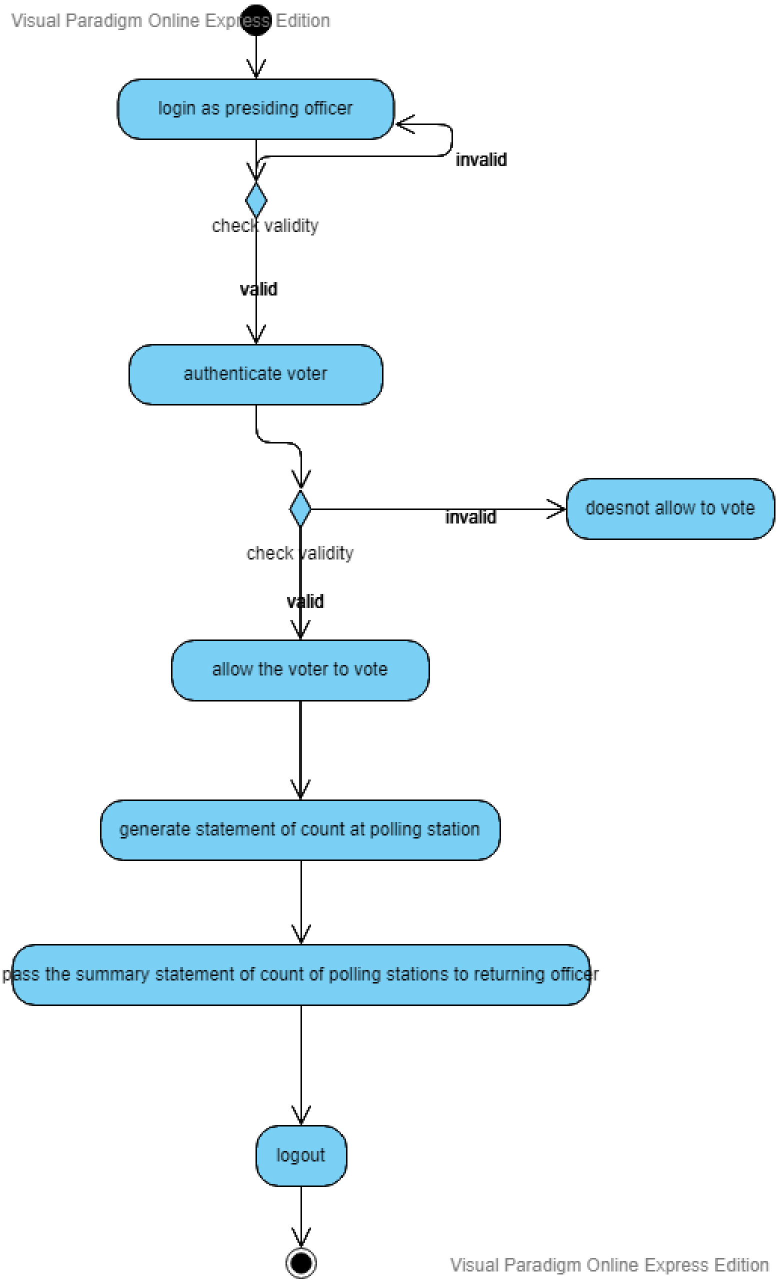

Visual Paradigm Online Express Edition
login as presiding officer
invalid
check validity
valid
authenticate voter
invalid
doesnot allow to vote
check validity
valid
allow the voter to vote
generate statement of count at polling station
pass the summary statement of count of polling stations to returning officer
logout
Visual Paradigm Online Express Edition

Figure 19 - Activity Diagram – Presiding Officer

4.2.6 Logical View (State Diagram)

Following is the state diagram of AGROBOT showing all the states that the system have during the course of action

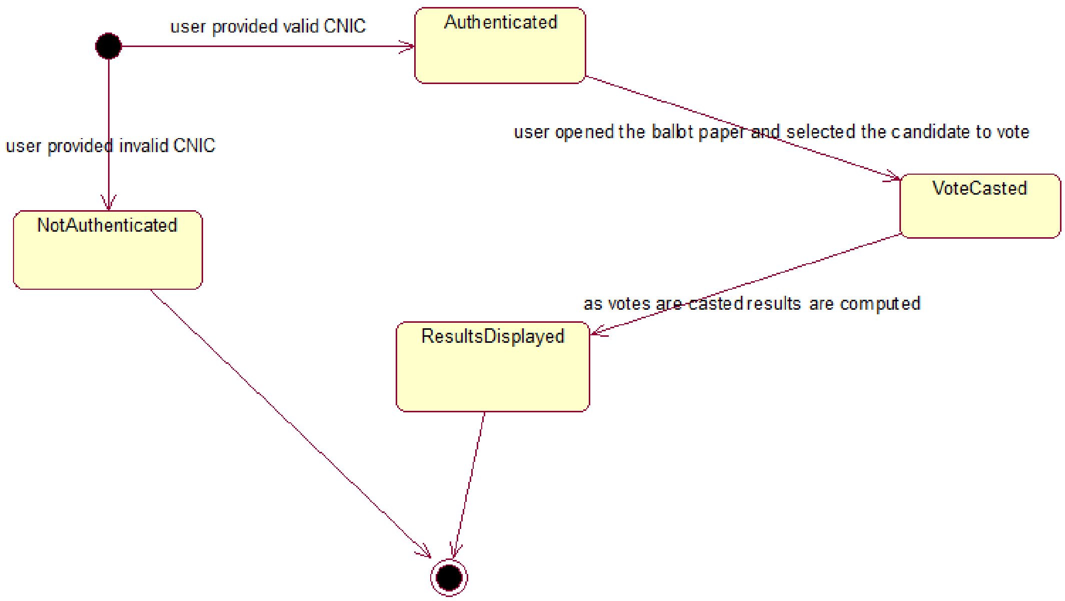

user provided valid CNIC
Authenticated
user provided invalid CNIC
user opened the balbt paper and selected the candidate to vote
NotAuthenticated
VoteCasted
as votes are casted results are computed
ResultsDisplayed

Figure 20 - State Diagram –User/Voter

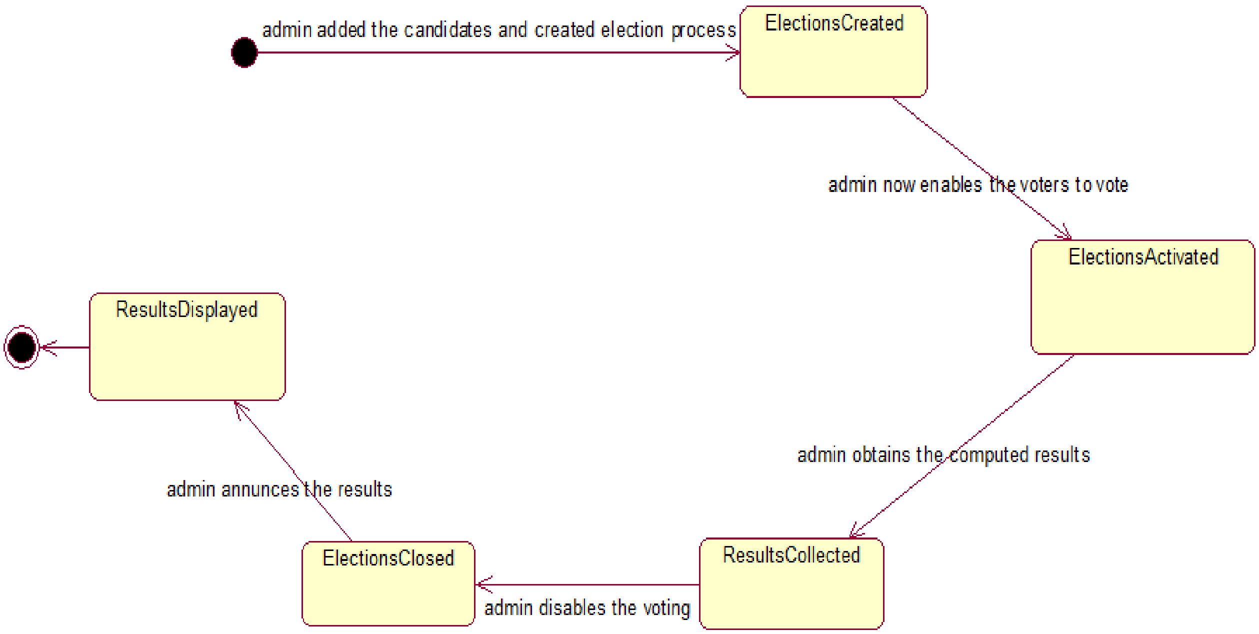
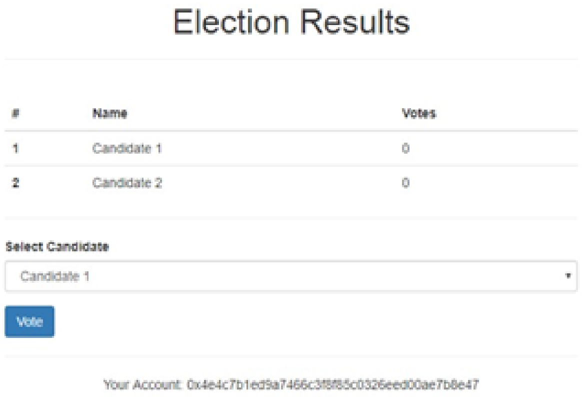

admin added the candidates and created election process
ElectionsCreated
admin now enables the voters to vote
ElectionsActivated
ResultsDisplayed
admin obtains the computed results
admin annunces the results
ElectionsClosed
ResultsCollected
admin disables the voting

Figure 21 - State Diagram –Admin

4.3 User Interfaces

Following diagrams show user interfaces and screens for VSCRYPT App.



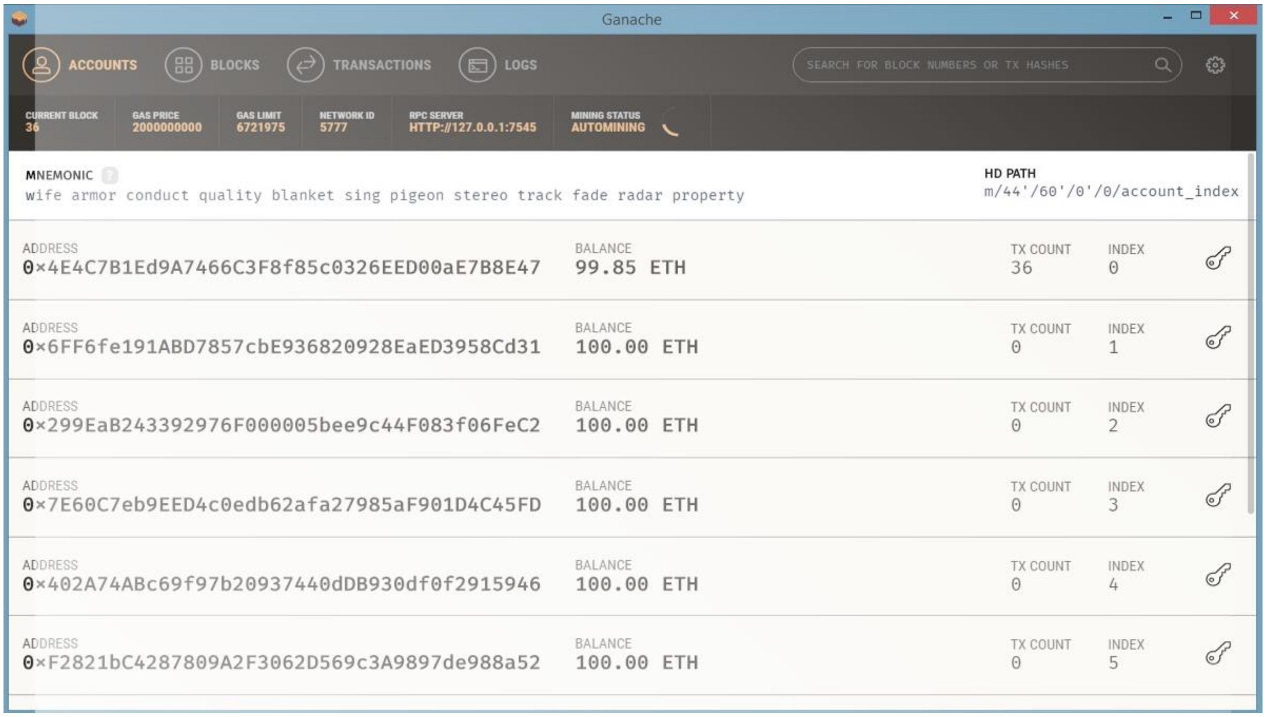
Election Results

#	Name	Votes
1	Candidate 1	0
2	Candidate 2	0

Select Candidate

Candidate 1 ▾

Your Account: 0x4e4c7b1ed9a7466c3f8f85c0326eed00ae7b8e47

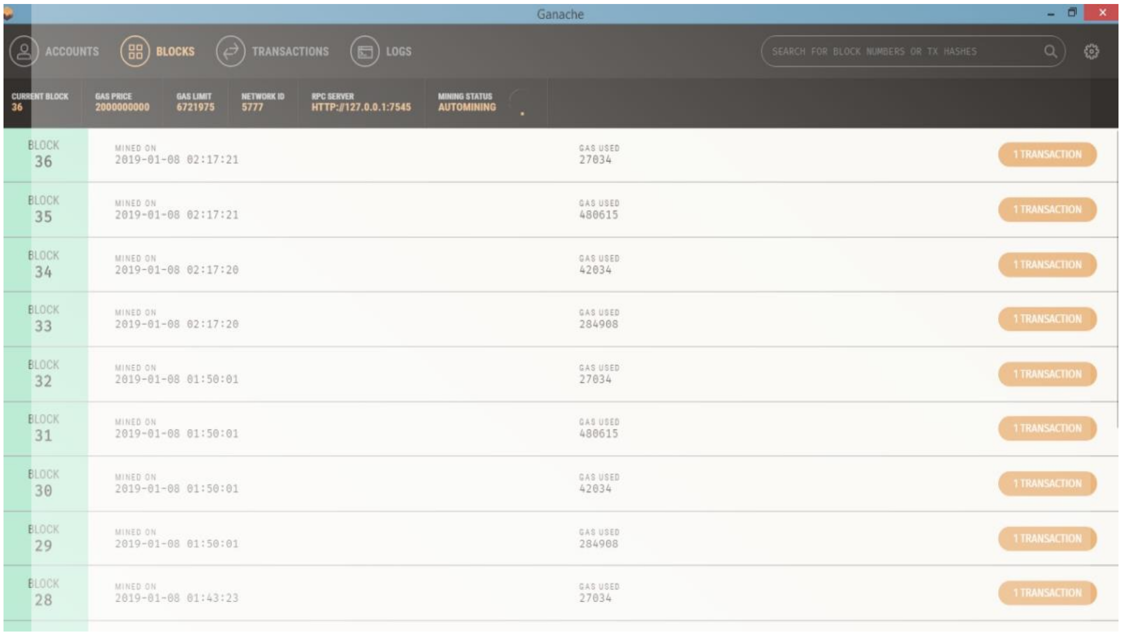


CURRENT BLOCK	GAS PRICE	GAS LIMIT	NETWORK ID	RPC SERVER	MINING STATUS
36	2000000000	6721975	5777	HTTP://127.0.0.1:7545	AUTOMINING

MNEMONIC
wife armor conduct quality blanket sing pigeon stereo track fade radar property

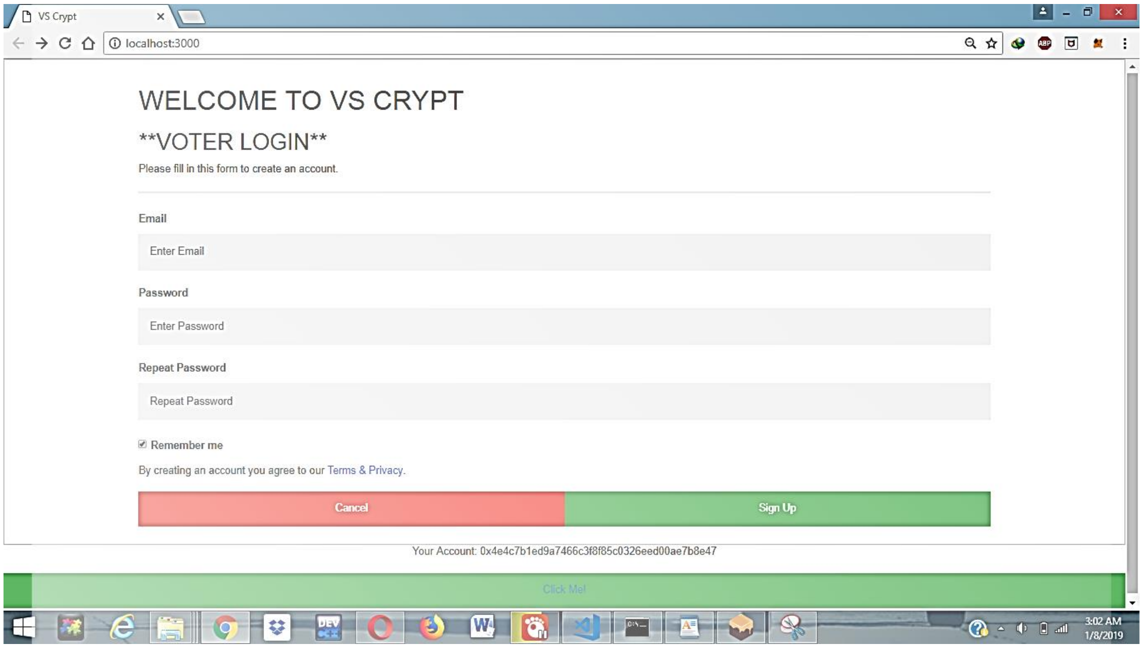
HD PATH
m/44'/60'/0'/0/account_index

ADDRESS	BALANCE	TX COUNT	INDEX
0x4E4C7B1Ed9A7466C3F8f85c0326EED00aE7B8E47	99.85 ETH	36	0
0x6FF6fe191ABD7857cbE936820928EaED3958Cd31	100.00 ETH	0	1
0x299EaB243392976F000005bee9c44F083f06FeC2	100.00 ETH	0	2
0x7E60C7eb9EED4c0edb62afa27985aF901D4C45FD	100.00 ETH	0	3
0x402A74ABc69f97b20937440dDB930df0f2915946	100.00 ETH	0	4
0xF2821bC4287809A2F3062D569c3A9897de988a52	100.00 ETH	0	5



CURRENT BLOCK	GAS PRICE	GAS LIMIT	NETWORK ID	RPC SERVER	MINING STATUS
36	2000000000	6721975	5777	HTTP://127.0.0.1:7545	AUTOMINING

BLOCK	MINED ON	GAS USED	
36	2019-01-08 02:17:21	27034	1 TRANSACTION
35	2019-01-08 02:17:21	480615	1 TRANSACTION
34	2019-01-08 02:17:20	42034	1 TRANSACTION
33	2019-01-08 02:17:20	284908	1 TRANSACTION
32	2019-01-08 01:50:01	27034	1 TRANSACTION
31	2019-01-08 01:50:01	480615	1 TRANSACTION
30	2019-01-08 01:50:01	42034	1 TRANSACTION
29	2019-01-08 01:50:01	284908	1 TRANSACTION
28	2019-01-08 01:43:23	27034	1 TRANSACTION



WELCOME TO VS CRYPT

VOTER LOGIN

Please fill in this form to create an account.

Email

Enter Email

Password

Enter Password

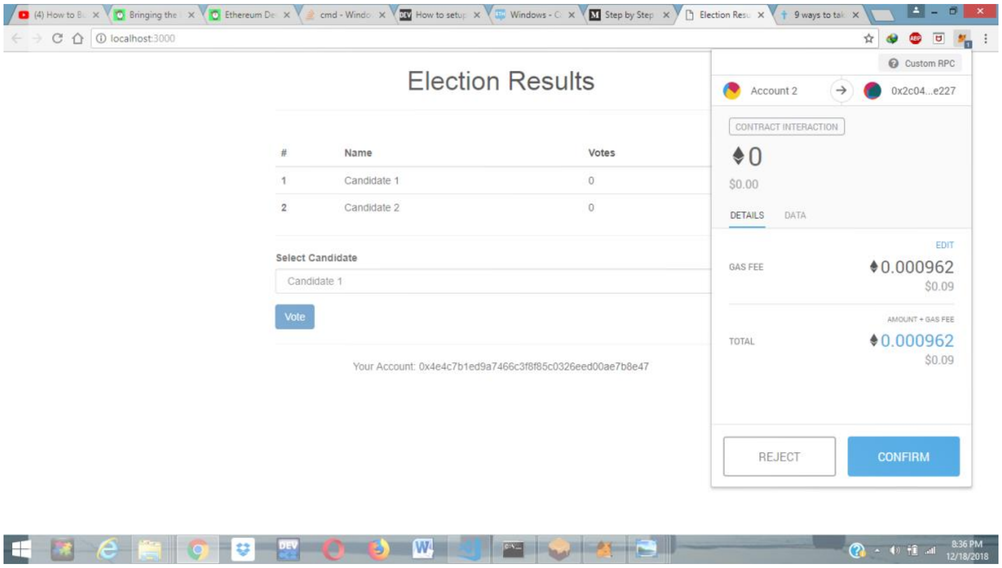
Repeat Password

Repeat Password

☑ Remember me

By creating an account you agree to our Terms & Privacy.

Your Account: 0x4e4c7b1ed9a7466c3f8f85c0326eed00ae7b8e47



Election Results

#	Name	Votes
1	Candidate 1	0
2	Candidate 2	0

Select Candidate

Candidate 1

Your Account: 0x4e4c7b1ed9a7466c3f8f85c0326eed00ae7b8e47

GAS FEE 0.000962 $0.09

AMOUNT + GAS FEE

TOTAL 0.000962 $0.09

5. Detailed Description of Components

This section describes in detail all the modules of VSCRYPT. These modules have been assigned responsibilities. Modules are further sub classified into components.

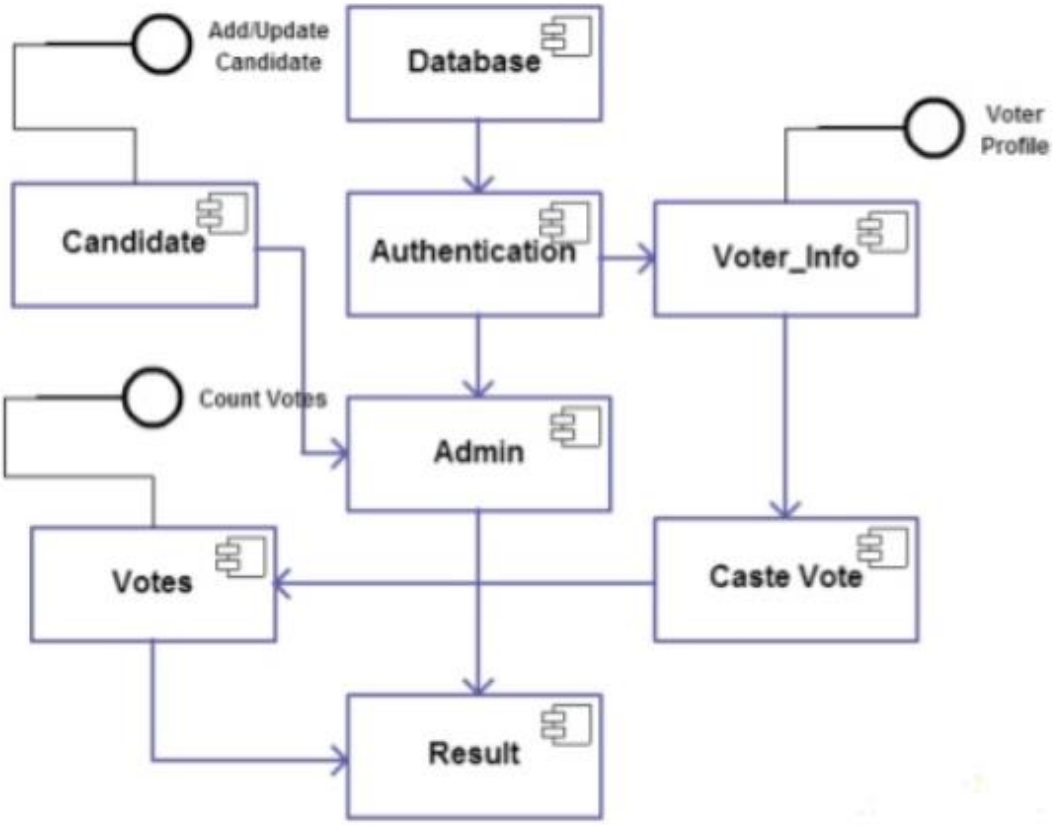


Figure 22 - Component Diagram

5.1 Authentication Module

Identification	Name: authentication
Type	Component
Purpose	to verify the user/voter
Function	This component of system authenticates the user so that only the correct user who meets the requirements can vote
Subordinates	Registration
Dependencies	This component is dependent on the registration process of the voter.
Interfaces	None.
Resources	Cryptographic algorithms.
Processing	This component will authenticate the user's data and compare to the defined rules for the authentication of the voter and authenticates it accordingly.
Data	This component uses the data entered by the user for further processing.

Table xxx - Authentication Module

5.2 Registration Module

Identification	Name: Registration
Type	Component
Purpose	to get user's data
Function	This component of system enables user to enter his/her data for the registration process to vote.
Subordinates	None
Dependencies	None
Interfaces	Signup interface.
Resources	Smart Contracts.
Processing	This component will enable the user to register him/ her for casting vote after entering required data.
Data	This component uses the data entered by the user for further

	processing.

Table xxxi - Registration Module

5.3 LogIn Module:

Identification	Name: Login
Type	Component
Purpose	to enable user or administrator to login to the account.
Function	This component of system authenticates the user/ administrator's id and password to give access to their respective accounts.
Subordinates	Registration, authentication.
Dependencies	This component is dependent on the registered authenticated voter.
Interfaces	LogIn interface.
Resources	None
Processing	This component will let user or administrator to login to their respective accounts and gives access to everyone accordingly.
Data	This component uses the login id and password.

Table xxxii - Login Module

5.4 Ballot Module:

Identification	Name: Ballot
Type	Component
Purpose	to provide ballot paper to the voter, and count the votes.
Function	This component of system authenticates that the ballot paper has not been assigned to the same voter before, then provides the ballot paper and counts the vote.
Subordinates	Login
Dependencies	This component is dependent on the login process of the voter.
Interfaces	Ballot paper.
Resources	Cryptographic algorithms, blockchain.

Processing	This component will authenticate that the same voter has not been provided with the ballot before, provides the ballot paper, enables the user to cast vote and counts vote for each candidate.
Data	This component uses the data transfered by the login module for further processing.

Table xxxiii - Ballot Module

5.5 Vote Casting Module:

Identification	Name: Vote Casting
Type	Component
Purpose	to verify the casted vote has been registered.
Function	This component of system authenticates that the casted vote has been registered.
Subordinates	Ballot
Dependencies	This component is dependent on the ballot module.
Interfaces	None.
Resources	Cryptographic algorithms, blockchain, ethers.
Processing	This component will authenticate the casted vote has been registered and enable the ethers to zero, so that no voter can cast vote again.
Data	This component uses the data entered by the ballot module for further processing.

Table xxxiv - Vote Casting Module

6. Reuse and Relationships to other Products

VSCrypt is basically a secure e-voting system using blockchain to resolve current issues relating to the elections in the country. It basically uses the current system hierarchy and administrative authorties and implies them into an electronic system instead of manual entries. It uses decentralized architecture integrated with blockchain and cryptographic algorithms ensuring transparency, security, authorization and privacy for the democratic elections being held in the country. Inspite of traditional ballot system, our system provides secure electronic voting. The blockchain structure is append-only data structure, i.e new blocks can be added but can not be ammended, deleted or created, in such a way that every block has a hash of the function linked to the previous block. The main features of the system includes Registeration, Voting, Verification, Counting and

Recounting. Some of the modules can be reused to enhance the product and add more functionality for the candidates or with the emerging market need.

7. Design Decisions and Tradeoffs

VSCrypt is an electronic system that inherits the existing, manual voting system being used in the democratic elections being held in the country and creates an e-voting system. The architecture of the system has been defined, and is divided into different modules mainly, Registeration, Voting, Verification, Counting and Recounting. Every module works independently following the whole procedure defined and passing the data to the next module.

Components work independently, but, in a certain flow (data as well as control). That leadsto high cohesion. Whereas, component don't have much interaction, once a component has completed its work system will generate an event for further action, consequently, the component registered for that event will come into action, leading to low coupling.

VSCrypt is basically an interactive system that requires interfaces and developing the system through necessary considerations and complexity problems, therefore the general pattern of MVC will be used, reducing the waste of resources and efficiency with a poor design.

8. TEST OBJECTIVE:

The objective of this document is to expand on the test plan and provide specific information needed to actually perform the necessary tests. By providing detailed test information, we hope to reduce the probability of overlooking items and improve test coverage. Testers will be able to use each test cases provided in this document to move forward and begin testing.

9. TEST ITEMS:

Based on the requirements of the project, VSCrypt following are the major modules/ functionalities that should be taken into account during the testing process:

1. Admin (DRO/RO/PO) Registration Module.
2. Voter Registration/ Authentication Module.
3. Vote Casting Module.
4. Results Generation/ Observation Module.
5. Database/ Blockchain Module.

10. FEATURES TO BE TESTED:

The features of our system include the functionality mentioned in our design document. Following features are to be tested keeping in view the test items and system features afore mentioned.

1. The system shall provide the welcome page to every user with login as voter and login as administrator.
2. For voter login, the system shall verify the entered NIC number from the database for the eligible voter.
3. For administrator login, the system shall provide the access to the legitimate users according to the chosen administrative post.
4. The system shall be able to enable users to know how eBallot works, including:
   A) Build your ballot.
   B) Notify your voters.
   C) Cast your vote.
   D) Analyze your results.
5. The system shall be able to show the summary of the voting activities including:
   A) Activity by day.
   B) Activity by time.
   C) Day by Day report.
6. The system shall be able to view ballot paper with all the candidates'along with their details.
7. The system shall be able to generate summaries of the votes with time, for every polling station including:
   A) Time remaining for polling.
   B) Total number of registered voters in the polling station.
   C) Total number of votes casted.
   D) Turnout.
8. The system shall be able provide ethers to every voter account.
9. The system shall be able to mine ethers for every block associated with every vote.

11. APPROACH:

Functional testing will focus on each use case that is included in the version currently being worked on. Testing will mainly consist of execution of test cases written to address the gap identified. It will focus on inputs, outputs and system changes due to actions. The testing strategy for VSCrypt will be Alpha testing that includes; black box testing and white box testing techniques. For testing functionality of each module blackboxtesting techniques will be used.

12. DETAILED TEST STRATEGY:

The project VSCrypt is a computationally intensive system that is why systems modules should be developed independently and then these modules should be integrated. Overall strategy comprises of Unit testing using White box testing and Black Box testing. Integration testing is performed in order to successfully integrate the system.

13. UNIT TESTING:

Unit testing is done at the source code level for language specific programming errors such as bad syntax, logic errors, or to test particular functions or code modules. The unit test cases shall be designed to test the validity of the programs correctness.

14. WHITE BOX TESTING:

In white box testing, the UI is bypassed. Inputs and outputs are tested directly at the code level in functions and the results are compared according to the requirements. This form of testing ignores the function of the program under test and will focus only on its code and the structure of that code. The test cases that have been generated shall cause each condition to be executed at least once. To ensure this happens, we are applying Basis (alternative) Path Testing. Because the functionality of the program is relatively simple, this method will be feasible to apply.

15. BLACK BOX TESTING:

Black box testing typically involves running through every possible input to verify that it results in the right outputs using the software as an end-user world.

16. INTEGRATION TESTING:

Integration testing is the part where we will test all the previous tested modules in a way that they are functioning normally when they are combined together.

17. INCREMENTAL TESTING:

There are five primary modules that are required to be integrated. These components, once integrated, will form the complete application testing. The following describes these modules as well as the steps that will need to be taken to achieve complete integration. We will be employing an incremental testing strategy to complete the integration. The integration testing will be performed by the development team.

17.1 **ADMIN/ DRO/ PO/ RO REGISTRATION MODULE:**

This module registers the admin, district returning officer returning officer and presiding officer for carrying out the election process from creating, activating, generating, and displaying results.

17.2 **VOTER REGISTRATION/ AUTHENTICATION MODULE:**

This module registers the voter and authenticates it whether he/she are allowed to vote or not.

17.3 **VOTE CASTING MODULE:**

This module allows the authenticated voter to cast vote.

17.4 **RESULT GENERATION/ OBSERVATION MODULE:**

This module generates the results which is validated and computed by PO, RO, DRO and admin at each hierarchy level

17.5 **DATABASE/ BLOCKCHAIN MODULE:**

This module will save the voting results in encrypted form on a node in blockchain which acts as a database.

18. SYSTEM TESTING:

In the end, system testing will ensure that all the modules are working, separately and together; combined. Then only the final outcome of the program will decide the correctness of whole system.

19. PERFORMANCE TESTING:

This test will be conducted to evaluate the fulfillment of a system with specified performance requirements. It will be done using black-box testing method, performed by:

- Checking out the response time of the system.
- Memory management of the program.

20. ITEMS PASS/ FAIL CRITERIA:

Details of the test cases are specified in the section Test Deliverables. Following the principles outlined below, a test item would be judged as pass or fail.

- Preconditions are met.
- Inputs are carried out as specified.
- The result works as what specified in output => Pass.
- The system doesn’t work or not the same as output specification => Fail.

21. SUSPENSION CRITERIA AND RESUMPTION REQUIREMENTS:

Testing procedure will be suspended whenever a defect is found that restricts further testing. A corrective measure will be applied depending upon the criticality of the defect and testing will be resumed.

Efforts have been made to remove all and every chance of failure but there are certain unpredictable factors such as network issues, corrupt input data, or system failure that may lead to some issues. Error handling is applied more deeply to cover all these issues but unforeseen circumstances may happen.

22. TEST DELIVERABLES:

22.1 **TESTING TASKS:**

- Develop test cases.
- Execute tests based on the test cases developed.
- Report defects during tests if any.
- Manage the changesmade after testing.

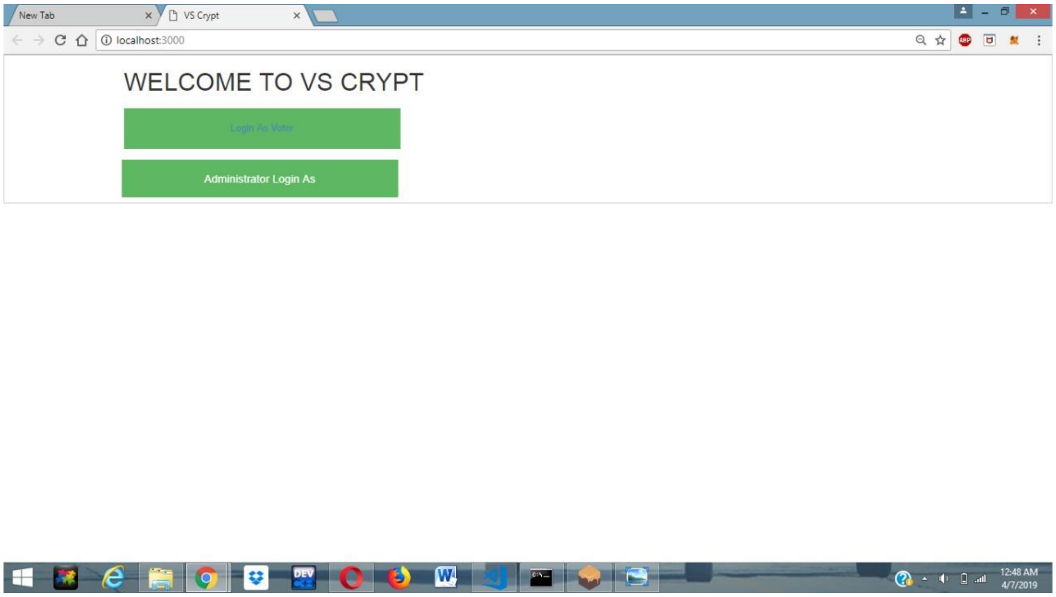
22.2 TEST CASES:

22.3 **TEST CASES:**

TEST CASE NAME	LOGIN Page
TEST CASE NUMBER	1
DESCRIPTION	It shall display the main menu once the application is launched.
TESTING TECHNIQUE USED	BlackBox testing
PRECONDITIONS	The user must have working internet connection to

	launch the application.
STEPS	Launch application on any web browser.
EXPECTED OUTPUT	User shall be able to see main menu in a virtual environment.
ACTUAL OUTPUT	Main menu displaying title “Welcome to VSCrypt” with options: - Voter login - Administrator login
STATUS	Pass

Table xxxv - Test Case Login Page



TEST CASE NAME	LOGIN Voter
TEST CASE NUMBER	2
DESCRIPTION	It shall display the voter registration process.
TESTING TECHNIQUE USED	BlackBox testing
PRECONDITIONS	- The user must have working internet connection to launch the application. - The user must be an eligible voter only then he can be registered as a voter.
INPUT:	The user entered numeric 13 digit number.
STEPS	- Launch application on any web browser. - Choose login as voter from the main menu.
EXPECTED OUTPUT	User shall be able to see CNIC tab to enter the NIC number number to be verified from the database.
ACTUAL OUTPUT	Main menu displaying:

	- NIC number tab - Submit button
STATUS	Pass

Table xxxvi- Test Case Login Voter

TEST CASE NAME	LOGIN Voter
TEST CASE NUMBER	3
DESCRIPTION	It shall display the voter registration process.
TESTING TECHNIQUE USED	BlackBox testing
PRECONDITIONS	- The user must have working internet connection to launch the application. - The user must be an eligible voter only then he can be registered as a voter.
INPUT:	The user entered numeric as well as alphabets.
STEPS	- Launch application on any web browser. - Choose login as voter from the main menu.
EXPECTED OUTPUT	User shall be able to see CNIC tab to enter the NIC number number to be verified from the database.
ACTUAL OUTPUT	Main menu displaying: - NIC number tab - Submit button
STATUS	Fail.

Table xxxvii- Test Case Login Voter

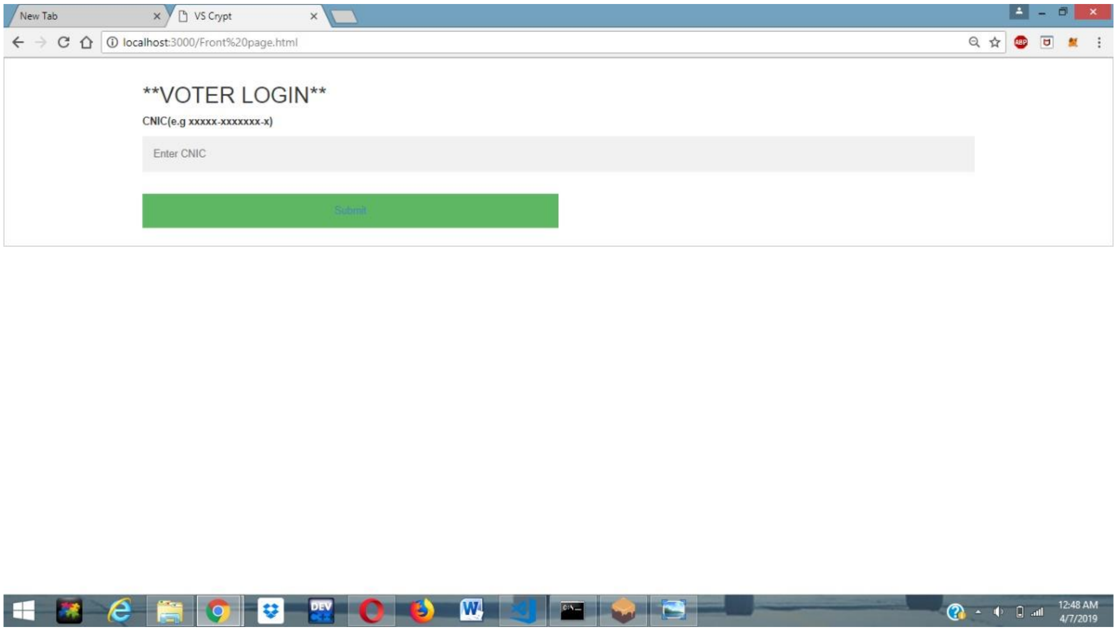
TEST CASE NAME	LOGIN Voter
TEST CASE NUMBER	4
DESCRIPTION	It shall display the voter registration process.
TESTING TECHNIQUE USED	BlackBox testing
PRECONDITIONS	- The user must have working internet connection to launch the application. - The user must be an eligible voter only then he can be registered as a voter.
INPUT:	The user entered alphanumeric 13 digit number.
STEPS	- Launch application on any web browser. - Choose login as voter from the main menu.
EXPECTED OUTPUT	User shall be able to see CNIC tab to enter the NIC number number to be verified from the database.

ACTUAL OUTPUT	Main menu displaying: • NIC number tab • Submit button
STATUS	Fail.

Table xxxviii- Test Case Login Voter

TEST CASE NAME	LOGIN Voter
TEST CASE NUMBER	5
DESCRIPTION	It shall display the voter registration process.
TESTING TECHNIQUE USED	BlackBox testing
PRECONDITIONS	• The user must have working internet connection to launch the application. • The user must be an eligible voter only then he can be registered as a voter.
INPUT:	The user entered numeric 21 digit number.
STEPS	• Launch application on any web browser. • Choose login as voter from the main menu.
EXPECTED OUTPUT	User shall be able to see CNIC tab to enter the NIC number number to be verified from the database.
ACTUAL OUTPUT	Main menu displaying: • NIC number tab • Submit button
STATUS	Fail.

Table xxxix- Test Case Login Voter



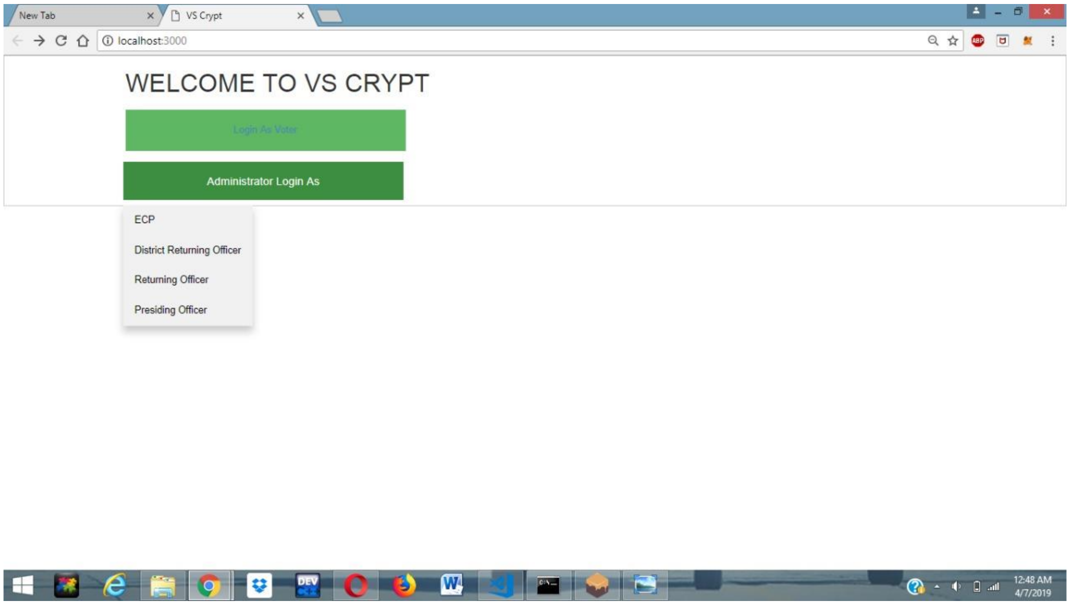
TEST CASE NAME	LOGIN Administrator
TEST CASE NUMBER	6
DESCRIPTION	It shall display the administrator login for the specified posts.
TESTING TECHNIQUE USED	BlackBox testing
PRECONDITIONS	• The user must have working internet connection to launch the application. • The user must be an eligible user only then he can get the administrative level access for the specified post.
STEPS	• Launch application on any web browser. • Choose login as administrator from the main menu. • Select your relevant post to gain the access.
INPUT	District Returning Officer.
EXPECTED OUTPUT	User shall be able to gain the admin level access defined for each corresponding posts.
ACTUAL OUTPUT	Main menu displaying: • ECP • District Returning Officer • Returning Officer • Presiding Officer
STATUS	Pass

Table xl- Test Case Login Administrator

TEST CASE NAME	LOGIN Administrator
TEST CASE NUMBER	7
DESCRIPTION	It shall display the administrator login for the specified posts.
TESTING TECHNIQUE USED	BlackBox testing
PRECONDITIONS	• The user must have working internet connection to launch the application. • The user must be an eligible user only then he can get the administrative level access for the specified post.

STEPS	• Launch application on any web browser. • Choose login as administrator from the main menu. • Select your relevant post to gain the access.
INPUT	Political Party.
EXPECTED OUTPUT	User shall be able to gain the admin level access defined for each corresponding posts.
ACTUAL OUTPUT	Main menu displaying: • ECP • District Returning Officer • Returning Officer • Presiding Officer
STATUS	Fail.

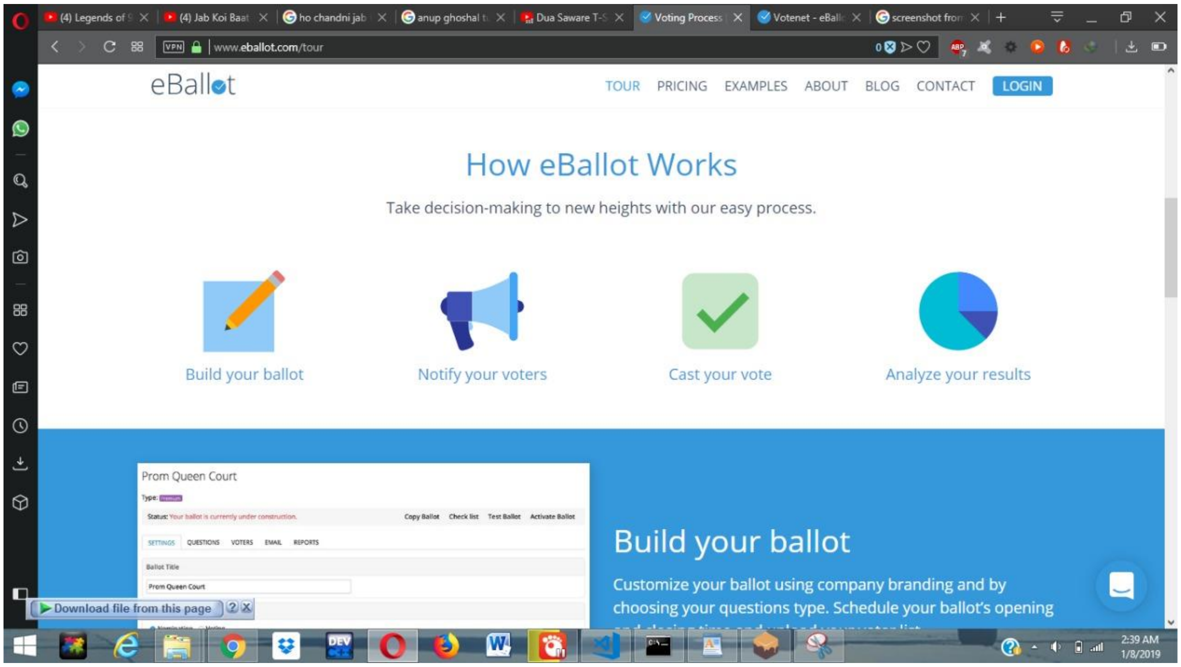
Table xli Test Case Login Administrator



TEST CASE NAME	eBallot
TEST CASE NUMBER	8
DESCRIPTION	It shall display how the eBallot works and it's including components.
TESTING TECHNIQUE USED	WhiteBox testing

PRECONDITIONS	- The user must have working internet connection to launch the application. - Eligible voter.
STEPS	- Launch application on any web browser. - Choose login as voter from the main menu. - Enter your NIC number and password to login.
EXPECTED OUTPUT	The menu shall display the steps required for the eBallot to work.
ACTUAL OUTPUT	Main menu with title “How eBallot Works” includes - Build you ballot. - Notify your voters. - Cast your vote. - Analyze your results.
STATUS	Pass

Table xlii Test Case eBallot



How eBallot Works

Take decision-making to new heights with our easy process.

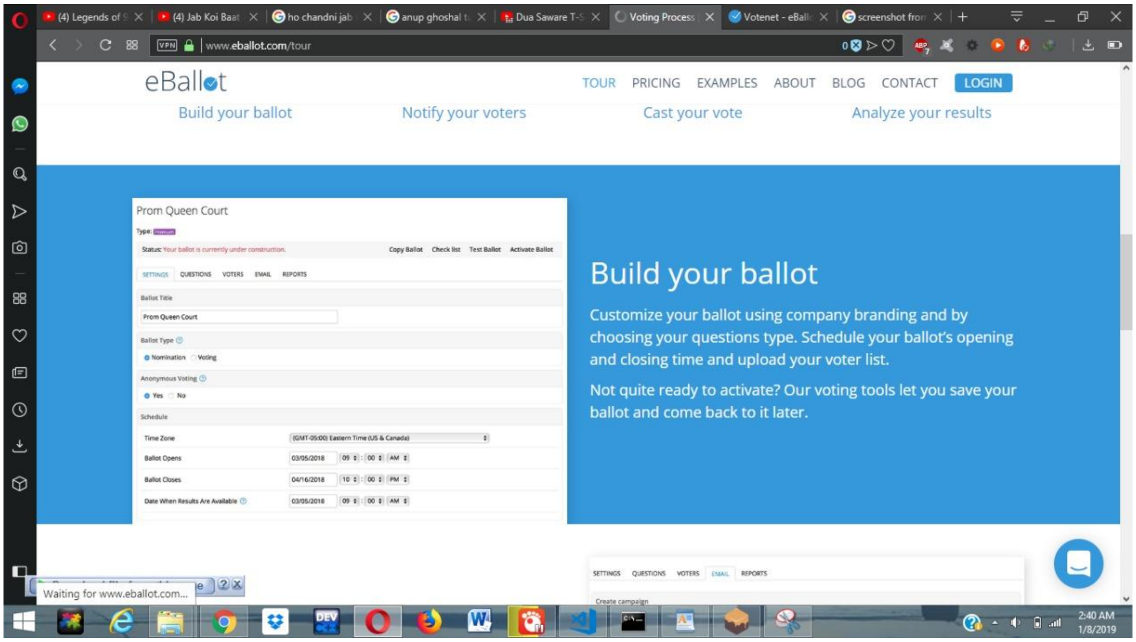
Build your ballot

Customize your ballot using company branding and by choosing your questions type. Schedule your ballot's opening

TEST CASE NAME	Build your ballot
TEST CASE NUMBER	9
DESCRIPTION	It shall display how the ballot can be built.
TESTING	WhiteBox testing

TECHNIQUE USED	
PRECONDITIONS	• The user must have working internet connection to launch the application. • Eligible voter.
STEPS	• Launch application on any web browser. • Choose login as voter from the main menu. • Enter your NIC number and password to login. • Select build your ballot from eBallot tab.
EXPECTED OUTPUT	The menu shall display the steps required for the eBallot to work.
ACTUAL OUTPUT	Main menu for building the ballot includes • Ballot title. • Ballot type. • Anonymous voting. • Schedule.
STATUS	Pass

Table xliii - Test Case Build Your Ballot



Prom Queen Court

Type: Premium

Status: Your ballot is currently under construction.

Ballot Title: Prom Queen Court

Ballot Type: ● Nomination ○ Voting

Anonymous Voting: ● Yes ○ No

Schedule

Time Zone: (GMT-05:00) Eastern Time (US & Canada)

Ballot Opens: 03/05/2018 09 : 00 AM

Ballot Closes: 04/16/2018 10 : 00 PM

Date When Results Are Available: 03/05/2018 09 : 00 AM

Build your ballot

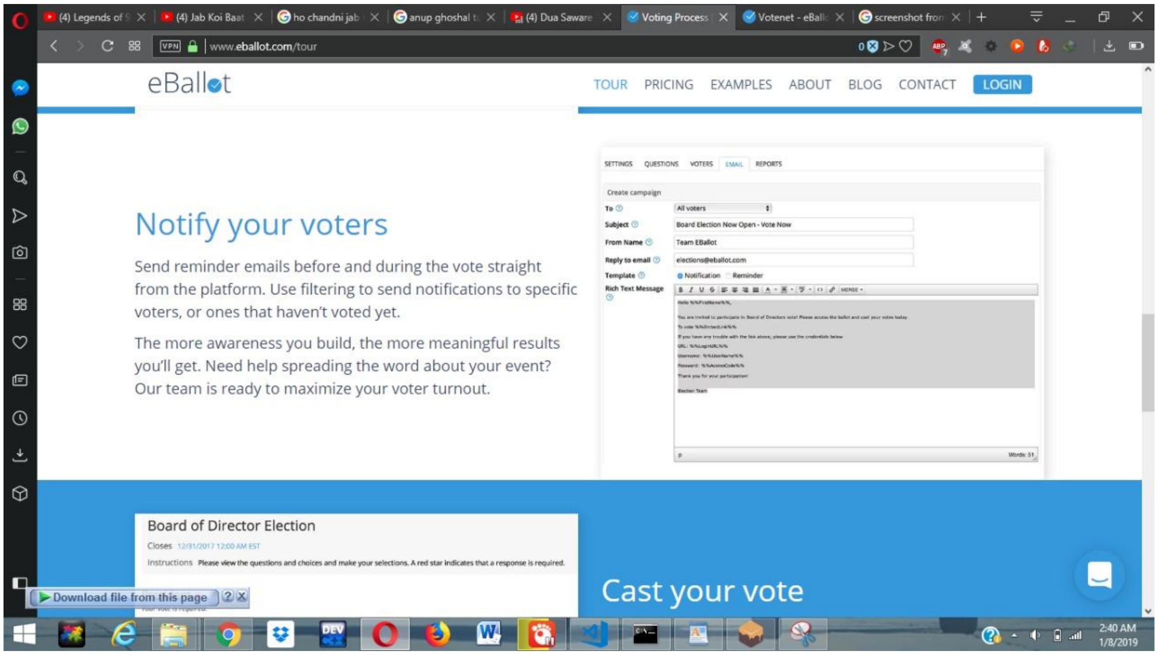
Customize your ballot using company branding and by choosing your questions type. Schedule your ballot's opening and closing time and upload your voter list.

Not quite ready to activate? Our voting tools let you save your ballot and come back to it later.

TEST CASE NAME	Notify your Voters
TEST CASE NUMBER	10
DESCRIPTION	It shall display how the voters can be notified.
TESTING	Whiteboxtesting

TECHNIQUE USED	
PRECONDITIONS	• The user must have working internet connection to launch the application. • Eligible voter.
STEPS	• Launch application on any web browser. • Choose login as voter from the main menu. • Enter your NIC number and password to login. • Select notify your voters from eBallot tab.
EXPECTED OUTPUT	The menu shall display the steps required for the eBallot to work.
ACTUAL OUTPUT	Main menu for notifying the voters include • Create campaign.
STATUS	Pass

Table xliv - Test Case Notify Your Votes



Notify your voters

Send reminder emails before and during the vote straight from the platform. Use filtering to send notifications to specific voters, or ones that haven't voted yet.

The more awareness you build, the more meaningful results you'll get. Need help spreading the word about your event? Our team is ready to maximize your voter turnout.

Create campaign

To: All voters

Subject: Board Election Now Open - Vote Now

From Name: Team EBallot

Reply to email: elections@eballot.com

Template: ● Notification ○ Reminder

Rich Text Message:

Hello %%FirstName%%,

You are invited to participate in Board of Directors vote! Please access the ballot and cast your votes today.

To vote %%EmbedLink%%

If you have any trouble with the link above, please use the credentials below

URL: %%LoginURL%%

Username: %%UserName%%

Password: %%AccessCode%%

Thank you for your participation!

Election Team

Words: 51

Board of Director Election

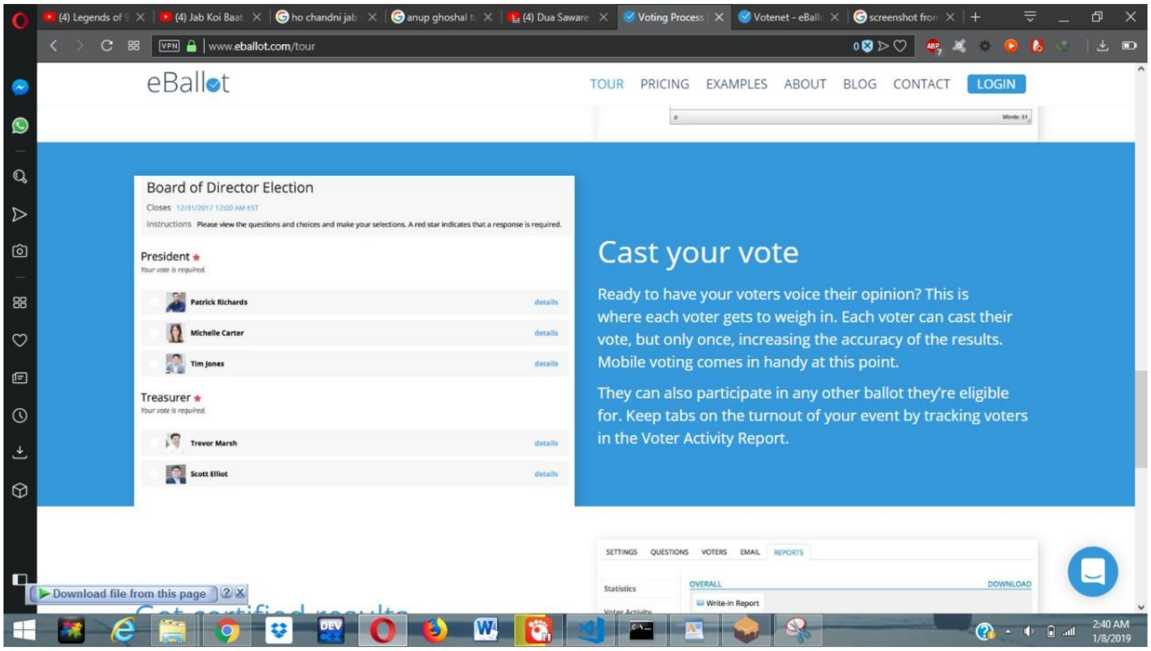
Closes 12/31/2017 12:00 AM EST

Instructions Please view the questions and choices and make your selections. A red star indicates that a response is required.

TEST CASE NAME	Cast your Votes
TEST CASE NUMBER	11
DESCRIPTION	It shall display how the votes can be casted.
TESTING TECHNIQUE USED	Whiteboxtesting

PRECONDITIONS	• The user must have working internet connection to launch the application. • Eligible voter.
STEPS	• Launch application on any web browser. • Choose login as voter from the main menu. • Enter your NIC number and password to login. • Select cast votes from eBallot tab.
EXPECTED OUTPUT	The menu shall display the steps required for the eBallot to work.
ACTUAL OUTPUT	Main menu for casting the votes include • Candidates running for elections. • Posts for which election is to be held.
STATUS	Pass

Table xlv- Test Case Cast Your Vote



Board of Director Election

Closes 12/31/2017 12:00 AM EST

Instructions Please view the questions and choices and make your selections. A red star indicates that a response is required.

President ★
Your vote is required.

Patrick Richards	details
Michelle Carter	details
Tim Jones	details

Treasurer ★
Your vote is required.

Trevor Marsh	details
Scott Elliot	details

Cast your vote

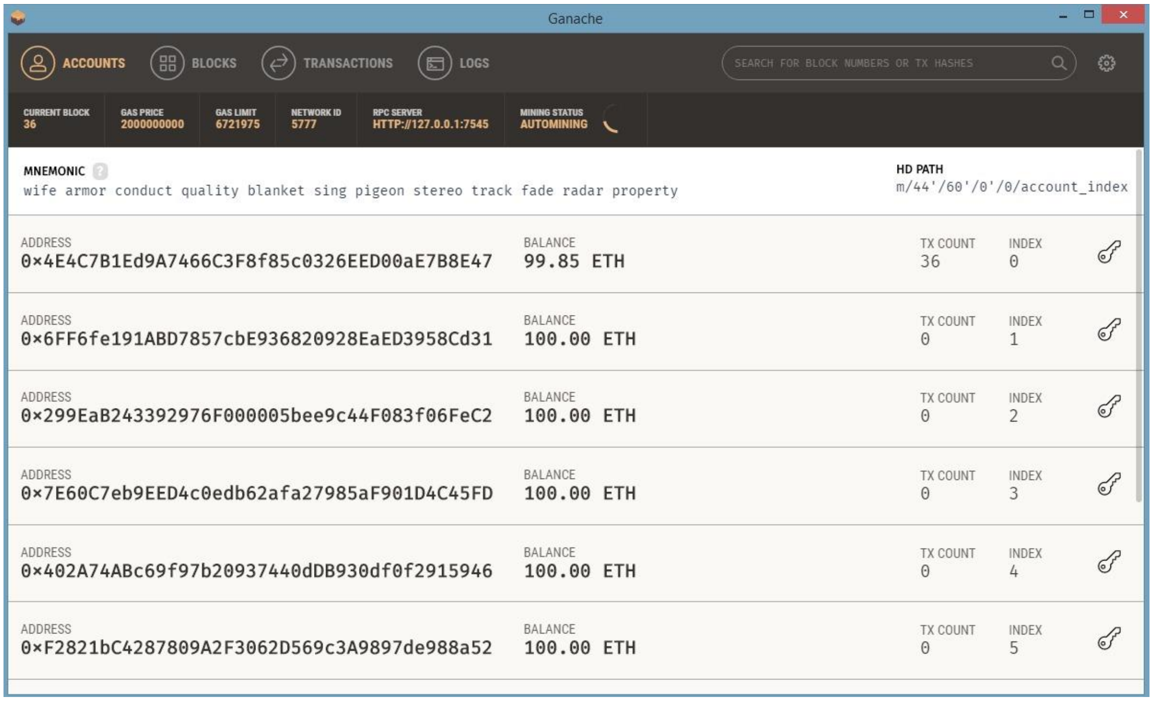
Ready to have your voters voice their opinion? This is where each voter gets to weigh in. Each voter can cast their vote, but only once, increasing the accuracy of the results. Mobile voting comes in handy at this point.

They can also participate in any other ballot they're eligible for. Keep tabs on the turnout of your event by tracking voters in the Voter Activity Report.

TEST CASE NAME	Ethers
TEST CASE NUMBER	12
DESCRIPTION	It shall add ethers to every voter’s account.
TESTING TECHNIQUE USED	Blackboxtesting

PRECONDITIONS	- The user must have working internet connection to launch the application. - Eligible voter.
STEPS	- Launch application on any web browser. - Choose login as voter from the main menu. - Enter your NIC number and password to login. - Select build the ballot and then cast vote.
EXPECTED OUTPUT	The menu shall display the ethers added to every voters account.
ACTUAL OUTPUT	Main menu containing the added ethers for every account.
STATUS	Pass

Table xlvi- Test Case Ethers



CURRENT BLOCK 36 | GAS PRICE 2000000000 | GAS LIMIT 6721975 | NETWORK ID 5777 | RPC SERVER HTTP://127.0.0.1:7545 | MINING STATUS AUTOMINING

MNEMONIC
wife armor conduct quality blanket sing pigeon stereo track fade radar property

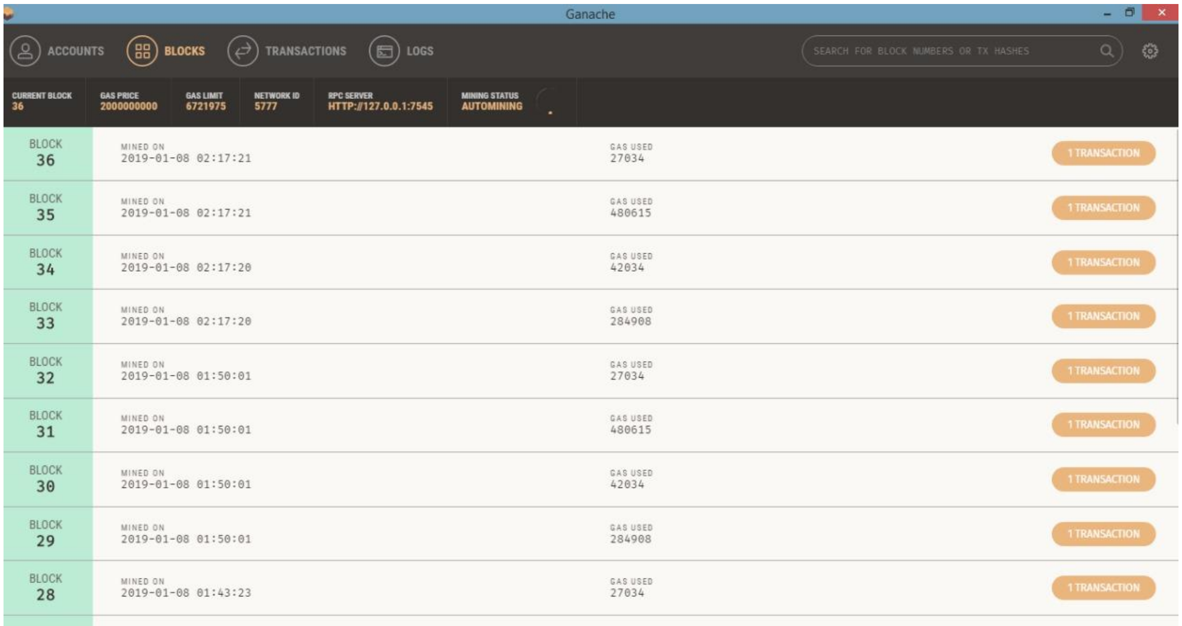
HD PATH
m/44'/60'/0'/0/account_index

ADDRESS	BALANCE	TX COUNT	INDEX
0×4E4C7B1Ed9A7466C3F8f85c0326EED00aE7B8E47	99.85 ETH	36	0
0×6FF6fe191ABD7857cbE936820928EaED3958Cd31	100.00 ETH	0	1
0×299EaB243392976F000005bee9c44F083f06FeC2	100.00 ETH	0	2
0×7E60C7eb9EED4c0edb62afa27985aF901D4C45FD	100.00 ETH	0	3
0×402A74ABc69f97b20937440dDB930df0f2915946	100.00 ETH	0	4
0×F2821bC4287809A2F3062D569c3A9897de988a52	100.00 ETH	0	5

TEST CASE NAME	Ethers Mining
TEST CASE NUMBER	13
DESCRIPTION	It shall show when the voter casted the vote and ethers are mined on every block.
TESTING TECHNIQUE USED	Blackboxtesting

PRECONDITIONS	• The user must have working internet connection to launch the application. • Eligible voter.
STEPS	• Launch application on any web browser. • Choose login as voter from the main menu. • Enter your NIC number and password to login. • Select build the ballot and then cast vote.
EXPECTED OUTPUT	The menu shall display the ethers left for every voter after casting the vote.
ACTUAL OUTPUT	Main menu containing the ethers left for every account with date and time specified for each ether used.
STATUS	Pass

Table xlvii- Test Case Ethers Mining



CURRENT BLOCK	GAS PRICE	GAS LIMIT	NETWORK ID	RPC SERVER	MINING STATUS
36	2000000000	6721975	5777	HTTP://127.0.0.1:7545	AUTOMINING

BLOCK	MINED ON	GAS USED	
36	2019-01-08 02:17:21	27034	1 TRANSACTION
35	2019-01-08 02:17:21	480615	1 TRANSACTION
34	2019-01-08 02:17:20	42034	1 TRANSACTION
33	2019-01-08 02:17:20	284908	1 TRANSACTION
32	2019-01-08 01:50:01	27034	1 TRANSACTION
31	2019-01-08 01:50:01	480615	1 TRANSACTION
30	2019-01-08 01:50:01	42034	1 TRANSACTION
29	2019-01-08 01:50:01	284908	1 TRANSACTION
28	2019-01-08 01:43:23	27034	1 TRANSACTION

TEST CASE NAME	Database connectivity
TEST CASE NUMBER	14
DESCRIPTION	It shall show when the voter casted the vote and it enters the blockchain.
TESTING TECHNIQUE USED	Blackboxtesting

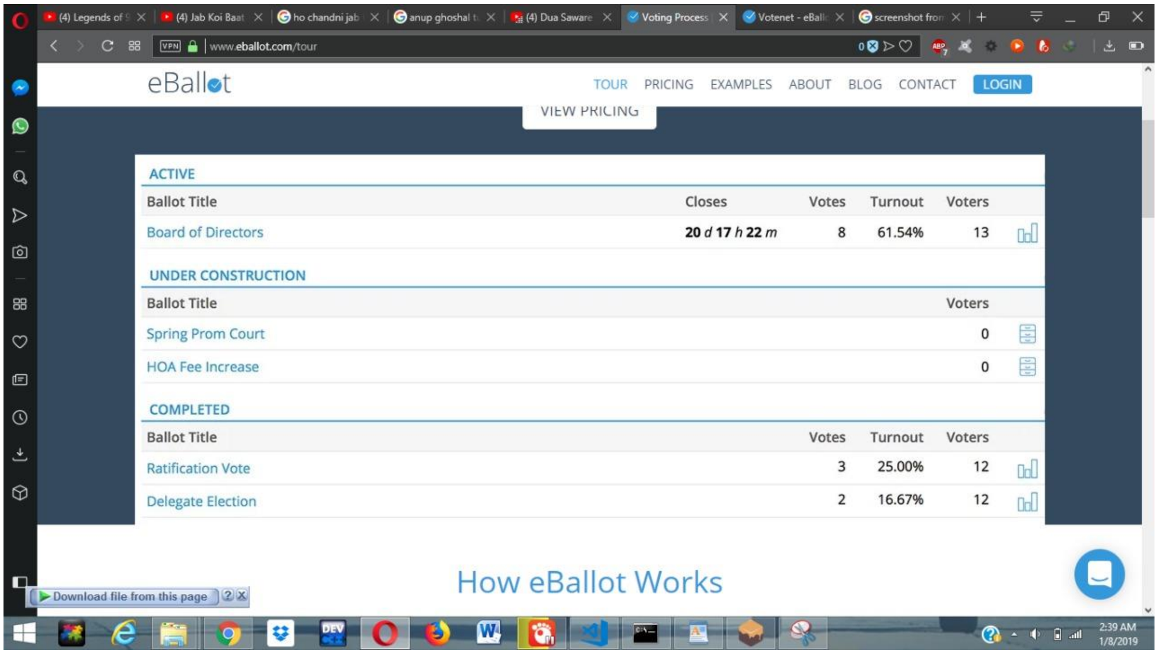
PRECONDITIONS	• The user must have working internet connection to launch the application. • Eligible voter.
STEPS	• Launch application on any web browser. • Choose login as voter from the main menu. • Enter your NIC number and password to login. • Select build the ballot and then cast vote.
EXPECTED OUTPUT	Blocks added to the blockchain.
ACTUAL OUTPUT	Blocks added to the database for every casted vote.
STATUS	Pass

Table xlviii- Test Case Database Connectivity

TEST CASE NAME	Summary generation.
TEST CASE NUMBER	11
DESCRIPTION	It shall show the voter casted the vote and ethers are mined on every block.
TESTING TECHNIQUE USED	Blackboxtesting.
PRECONDITIONS	• The user must have working internet connection to launch the application. • Eligible voter.
STEPS	• Launch application on any web browser. • Choose login as voter from the main menu. • Enter your NIC number and password to login. • Select build the ballot and then cast vote.
EXPECTED OUTPUT	The menu shall display the summary for every polling station.
ACTUAL OUTPUT	Main menu displaying the summary for every polling station including: • Ballot title. • Registered voters in a polling station. • Time remaining to cast vote. • Number of votes casted. • Turnout.

STATUS	Pass

Table xlix- Test Case Summary Generation



ACTIVE

Ballot Title	Closes	Votes	Turnout	Voters
Board of Directors	20 d 17 h 22 m	8	61.54%	13

UNDER CONSTRUCTION

Ballot Title	Voters
Spring Prom Court	0
HOA Fee Increase	0

COMPLETED

Ballot Title	Votes	Turnout	Voters
Ratification Vote	3	25.00%	12
Delegate Election	2	16.67%	12

23. ENVIRONMENT NEEDS:

23.1 HARDWARE:

- Computer/ Smartphone.
- Internet connection

23.2 SOFTWARE:

- Truffle
- Node js
- Metamask
- Visual studio code

23.3 RESPONSIBILITIES, STAFFING AND TRAINING NEEDS:

23.3.1 RESPONSIBILITIES:

All developers of the project are responsible for the completion of all units testing and integration testing tasks.

23.3.2 STAFFING AND TRAINING NEEDS:

Basic knowledge of testing strategies and techniques are needed for testing the project. Techniques such as blackboxtesting, integration testing should be known to the developers. All the developers will be testing each other's work and will be actively participating in the development and testing of the project simultaneously.

23.4 **SCHEDULE:**

23.4.1 **IMPORTANT DATES:**

1. Unit testing and integration testing will be finished by April, 2019 as will the development process.
2. Acceptance testing will be performed right after the development process completes.

23.4.2 **RISK AND CONTIGENCIES:**

Efforts have been made to remove all and every chance of failure but there are certain unpredictable factors such as network issues, corrupt input data, or system failure that may lead to some issues. Error handling will be applied more deeply to cover all these issues but unforeseen circumstances may happen.

23.4.3 **SCHEDULE RISK:**

The project might get behind schedule so in order to complete the project in time we will be needing to increase the hours/ day that the project is being worked on.

23.4.4 **OPERATIONAL RISK:**

Operational risk will be eliminated by scheduling daily meeting and regular deadlines to meet the goals of the project as well as provide proper communication within the group.

23.4.5 **TECHNICAL RISK:**

Technical risk will be eliminated by keeping the once defined requirements constant.

23.4.6 **PROGRAMMATIC RISK:**

In case of programmatic risk the scope of the project will be limited in order to stay inside the constraints of the project.

23.4.7 **BUDGET RISK:**

The budget will be compressed by using less costly alternatives to fit the budget requirements, if added.

CONCLUSION

By utilizing the modern technology features, we have developed a web application addressing the diverse needs in the country for the general elections being held in the country focused on improving the overall system of elections in the country and overcome the problems in conventional voting system. It was designed and developed with detailed research on the current system of elections, conventional ballot system and roles and responsibilities of the individuals, part of the election system, to verify the transparency of the votes and overall voting system and making it easier and convenient for everyone to vote over a brief period of application usage. The preliminary results of application evaluation showed the promising effectiveness of developed application in advancing the overall performance of the votes and their transparency which otherwise was hard to observe.

The initial evaluation yielded that both the user interface design and learning content structure of the application fulfills the elicited requirements of voting system. Since the application implements a great deal of learning material design based on blockchain, therefore it is expected to prove as an efficient and cost effective technology based system solving the the issue of voting system on national level with technology awareness, efficiency, transparency and accessibility.

GLOSSARY:

ECP: Election Commission of Pakistan
RO: Returning Officer
DRO: District Returning Officer
PO: Presiding Officer
SRS: Software Requirement Specification
SDS: Software Design Specification
UML: The Unified Modeling Language (UML) is a general-purpose modeling language in the field of software engineering, which is designed to provide a standard way to visualize the design of a system

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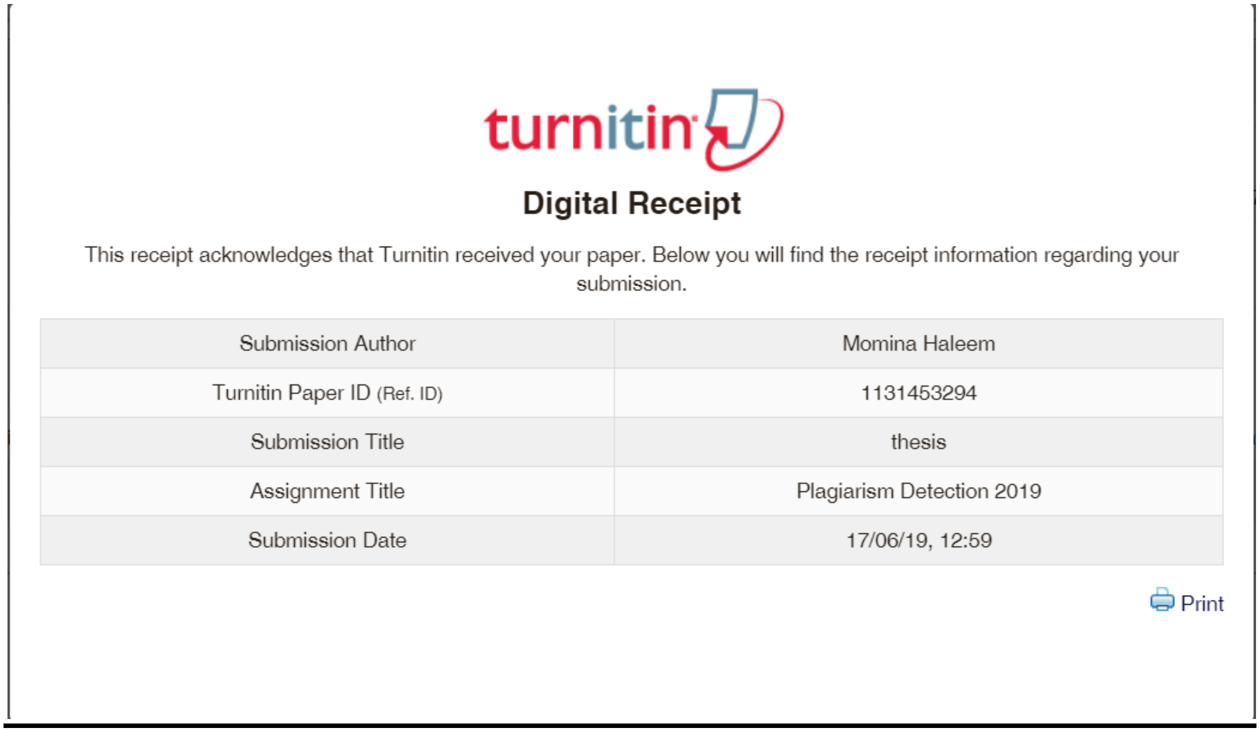

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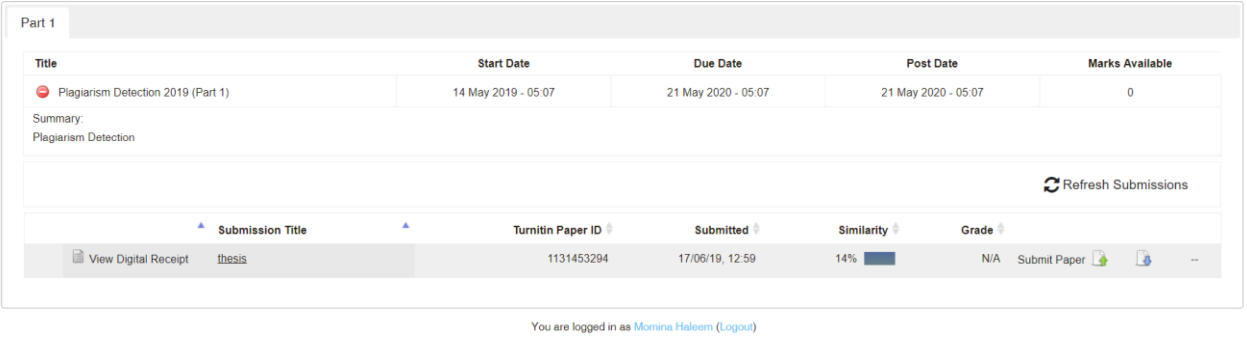

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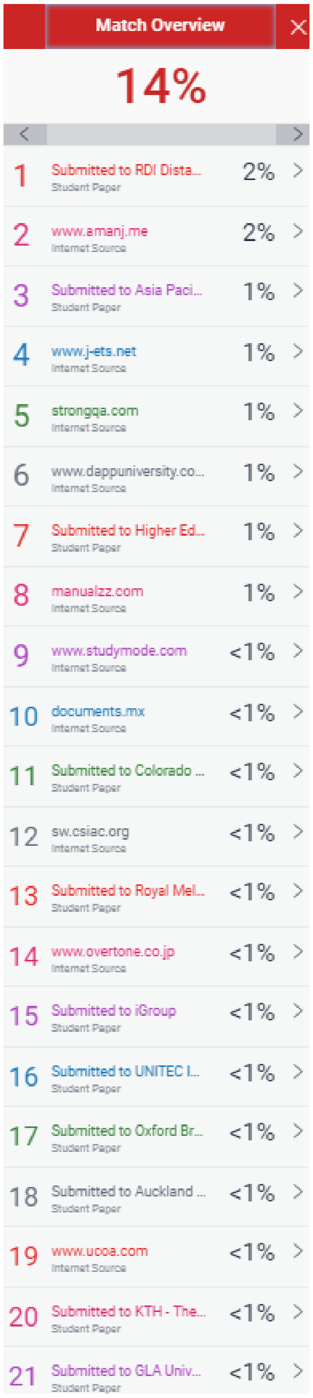

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