(Group 2)

(Elect and Verify (EnV): A system for online verifiable elections)

Software Design Document (SDD)

Prepared By:

Ahmed Abd El Fattah Ewais
Hussam Ashraf El-Araby
Islam Faisal Ibrahim
Mohamed Amr Gadalla

Supervised by:

Dr. Sherif El-Kassas
Mr. Hossam Medhat

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1. Introduction

1.1. Document Purpose

The purpose of this Software Design Document (SDD) is to give an overview of the system architecture, the communication and interfaces, as well as the design of each component. The SDD includes various graphical diagrams that explain the design in more details such as architecture, context, class and sequence diagrams. The intended audience of this document are the client engineers as well as the development, testing and deployment team. Client engineers should review the SDD to make sure the design meets their business needs. The development team shall use this as the main reference during the development of the high level details of the system. Testing team shall use the document to generate load tests, unit tests and integration tests. Deployment team shall take into consideration the backup, interface and communication notes outline in the document.

1.2. Document Scope

This document is a software design document for the online digital democracy solution ***Elect and Verify***. This document is a follow-up for the software requirements specification (SRS) published earlier in November, 2015. *EnV*'s main goal is to make the whole campaigning, voting and result publishing online and at the same time maintaining the privacy of ballots and integrity of the elections. The elections laws and rules are flexible and can be determined via configuration files. *EnV* allows the users to verify the elections and tallying process.

1.3. Document Overview

This document starts with an introduction explaining the motivation of the software, scope of the project and purpose of the document. The document then highlights and explains in details

1.4. Reference Material

[1] B. Schneier, *Applied cryptography*. New York: Wiley, 1996.

[2] A. Ewais, H. El-Araby, I. Faisal and M. Gadalla, *Software Requirements Specification For Elect and Verify (EnV): A system for online verifiable elections*, November 2015.

1.5. Definitions, acronyms and abbreviations

Table 1: Important Definitions

Term	Definition
Administrators, (System)	System users who are in charge of technical configurations, installations and maintenance.
Ballot	A secured verifiable cast vote.
Candidate	A person who is running for elections.
Elect and Verify (EnV)	The whole system (see system) and all its documentation, and accompanying source code and design documents.
Election	The process of asking a group of people for choices in a private aggregated way.
Officials, Elections	Users of the system who are authorized to configure all the election configurations and laws.
Subsystem	Any partial component or communication interface of the system.
System, (The)	The whole electoral system including the registration, pre-elections, voting, counting, verification, campainging and debating subsystems with all its offline and online components.
Trustees, Elections	Users of the system who are capable of collabroatively issue tallying requests.
Type, Election	The type of elections including the type of candidates and voting type.
Voters, (Eligible)	All eligible voters who can participate in an election.

Table 2: Important acronyms

Acronym	Meaning
API	Application Programming Interface
CAPTCHA	Completely Automated Public Turing test to tell Computers and Humans Apart
CRUD	Create, Read, Update and Delete
CSRF	Cross-Site Request Forgery
DBMS	Database Management System
DoS	Denial-of-Service
EnV	Elect and Verify (The system)
HTTP	Hypertext Transfer Protocol

HTTPS	Hypertext Transfer Protocol over Transport Layer Security
IP	Internet Protocol
JSON	JavaScript Object Notation
MVC	Model–view–controller
OOP	Object-Oriented Programming
REST	Representational State Transfer
TCP	Transmission Control Protocol
TLS	Transport Layer Security
UI	User Interface
XSS	Cross-site scripting

2. System Overview

This section gives a high-level picture of the system, its boundaries, and interaction with external systems, business process and main functionalities.

2.1. Product Perspective

EnV is intended to replace traditional paper-based voting systems as well as online voting systems whose results cannot be publicly audited. EnV is an online verifiable open-audit voting system. EnV also includes solutions for electoral campaigns and debates. EnV is not designed however to solve the problem of coercion.

2.2. System Context

The system interacts with different external systems and a database to ease the work. Figure 2.1. is a context diagram that represents these relations and interactions in an abstract way with respect to EnV, our system.

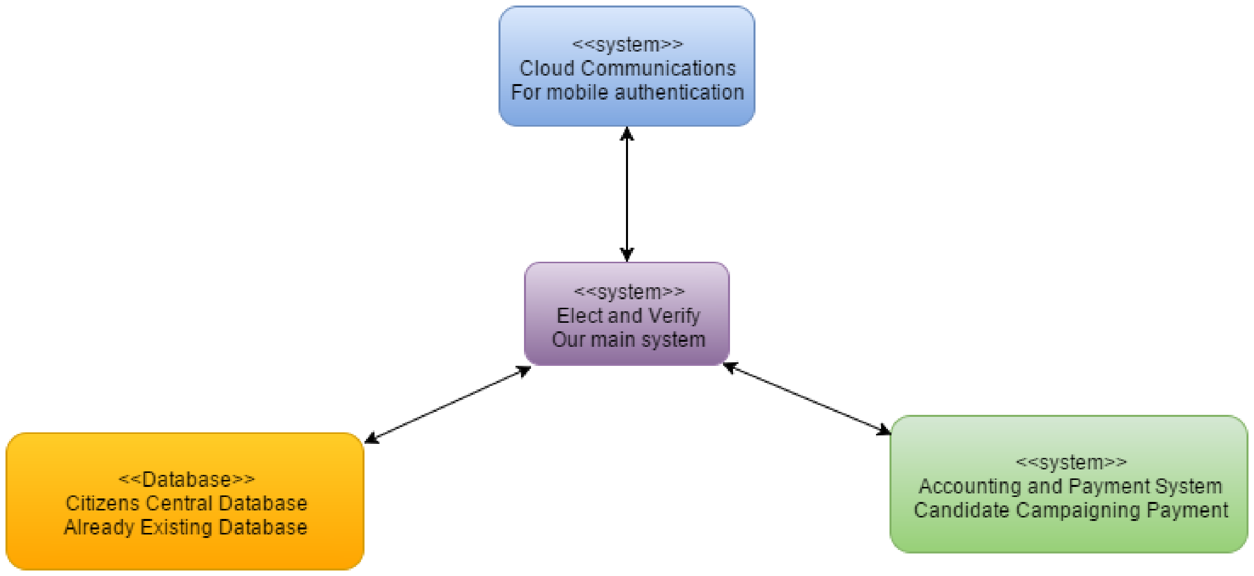

<<system>>
Cloud Communications
For mobile authentication
<<system>>
Elect and Verify
Our main system
<<Database>>
Citizens Central Database
Already Existing Database
<<system>>
Accounting and Payment System
Candidate Campaigning Payment

Figure 2.1: Context diagram for the system and its boundaries

2.3. Process Model

Figure 2.2 demonstrates the main business process of the system. More details are provided in sequence diagrams for different important parts of the system.

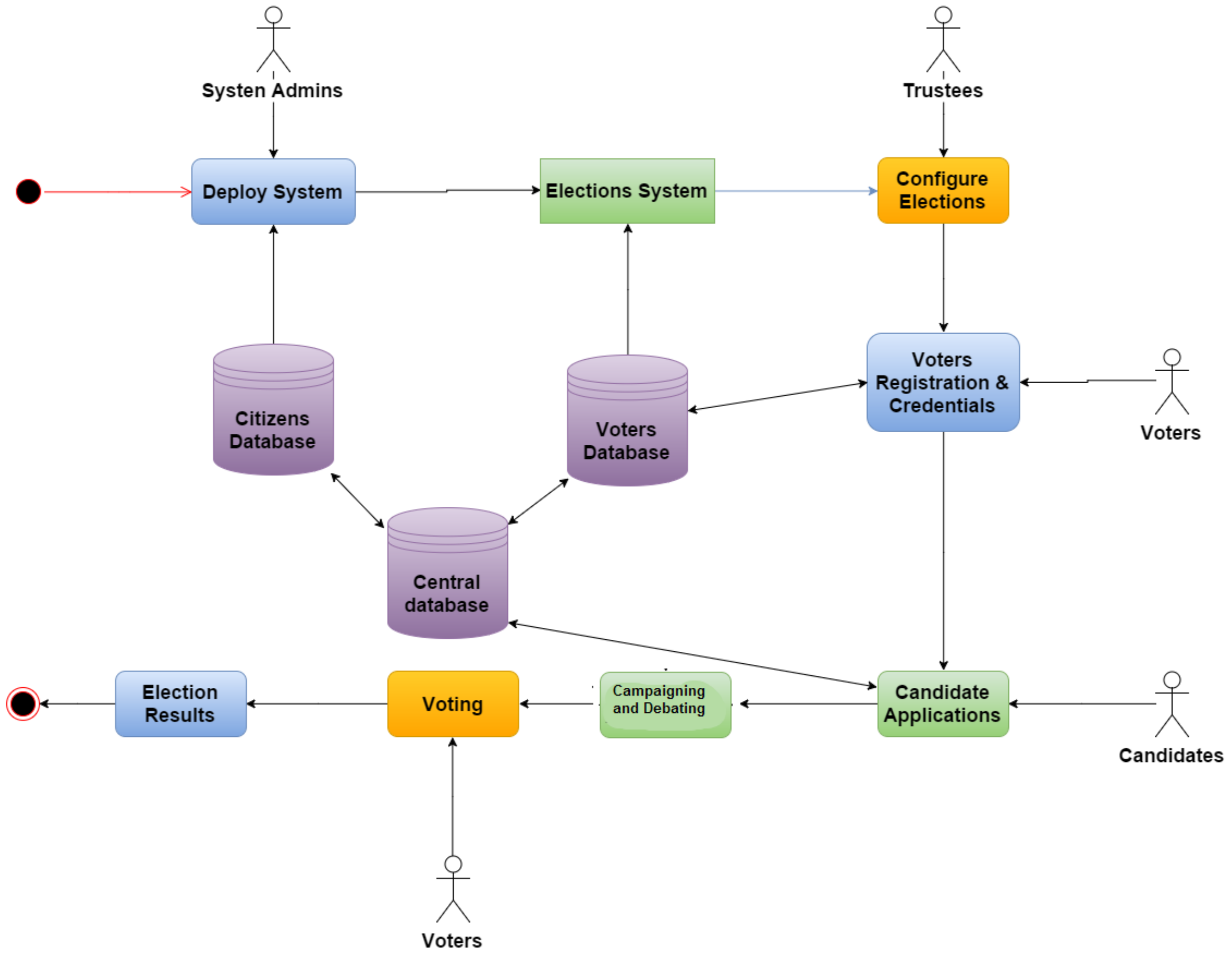


Figure 2.2: The process model of the system as a whole

2.4. Product Functions

EnV will provide functions for elections officials to organize elections, configure the voting system and candidates' eligibility, receive nominations, invite voters and organize debates between candidates. Details of these functionalities are listed and discussed in section 3 as well as the appendices.

2.3.1. Pre-Elections and Voters Registration

The aim of pre voting is to give candidates or parties, who wish to participate in the elections, the opportunity to register for the vacant places and compete in the elections. The registration process includes registration and eligibility check to make sure that the candidates are fit to fulfill the position's mission and goals.

2.3.2. Debating and campaigning

This platform's main goal is to allow candidates to publish content of their campaign to let voters know about them. This platform will also facilitate debates between different candidates that can be viewed by the voters.

2.3.3. Voting

This is the core functionality of the system. This module should provide a secure verifiable way of casting ballots. Each voter should be able to cast their ballots for the candidate they want. After the conclusion of the elections, the voters should be able to verify their vote. No votes can be duplicated without being detected.

2.4. User Classes and Characteristics

EnV is an online system that makes it possible to handle the campaigning, debating and actual elections online, and so the targeted actors are: public viewers, voters, candidates, system administrators, trustees and debate moderators.

All the users are expected to know how to read either Arabic or English as the system interface will offer both, and also they are expected to know how to deal with web browsers and electronic devices such as mobiles or personal computers since the system is an online system. Trustees, however require further training on how to keep confidential data secure. The following subsection provides more details about each user role.

2.4.1. Elections Trustees

Elections officials are responsible for setting the elections type, inserting the elections laws and protocols in the system and updating the eligible voters' database before the elections. Trustees will feed eligibility information of both candidates and voters to the system and will deal with all legal lists and databases. In case of building a Helios [2] similar system, elections trustees are responsible for initiating the elections by providing the public keys and share the keys that decrypt the tallies.

2.4.2. System Administrators

A system administrator is a logged in user that creates, sets up, and updates the system platform. Every subsystem will have a different group of admins. System administrators are responsible for technical details of the system, backups, logs, maintenance and providing help to other user roles. The authority must be distributed between all system administrators. Sensitive functionalities require multi-user authentication.

2.4.3. Voters

A voter must be an eligible voter and his name must be in the list of eligible citizens to vote that will be provided by the government, otherwise he will not be able to sign up for the online voting.

2.4.5. Candidates

Candidates are the political parties or persons that will be running for the elections depending on whether the elections is list or individuals based. Candidates must be eligible to run for this elections, he must be able to handle his personal space and publish content online. He is expected to behave in ethical manners.

2.4.6. Public Viewers

A public viewer is a person or search engine that has internet access and is able to navigate to the system's web address. He may not be logged in. Public viewers including search engines are viewers to the voting portal, campaigning and debating system who are not authenticated or do not have credentials.

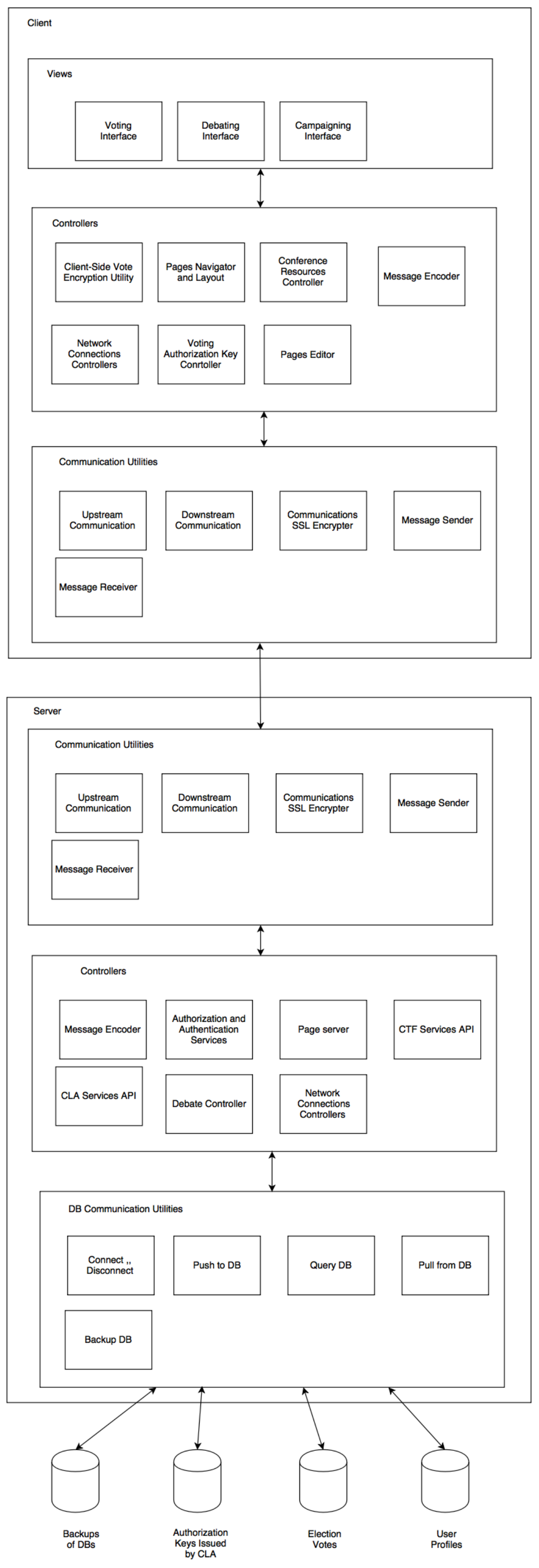
2.4.7. Debate Moderators

A debate moderator is a logged in user that represents a well-known public figure that is assigned by the system administrator prior to each debate. He is responsible for debating with the candidate(s) moderating the debate.

3. **System Architecture**

3.1 Architectural Design

The diagram below describes main system components, and the way they are organized. (Clearer diagram is in the folder provided with submission).


Client
Views
Voting Interface
Debating Interface
Campaigning Interface
Controllers
Client-Side Vote Encryption Utility
Pages Navigator and Layout
Conference Resources Controller
Message Encoder
Network Connections Controllers
Voting Authorization Key Conrtoller
Pages Editor
Communication Utilities
Upstream Communication
Downstream Communication
Communications SSL Encrypter
Message Sender
Message Receiver
Server
Communication Utilities
Upstream Communication
Downstream Communication
Communications SSL Encrypter
Message Sender
Message Receiver
Controllers
Message Encoder
Authorization and Authentication Services
Page server
CTF Services API
CLA Services API
Debate Controller
Network Connections Controllers
DB Communication Utilities
Connect ,, Disconnect
Push to DB
Query DB
Pull from DB
Backup DB
Backups of DBs
Authorization Keys Issued by CLA
Election Votes
User Profiles

3.2 Decomposition Description

The software architecture is a hybrid between *client-server architecture, layered* and *MVC* patterns. The client (voter or candidate) communicates with the server (our system), and then the server application communicates with the databases in the system.

The client side consists of:

1. (Topmost Layer) Views
    a. Voting Interface: The interface, buttons, and forms used in the voting and voting registration process.
    b. Debating Interface: The interface, buttons, and forms used in the debate rooms.
    c. Campaigning Interface: The interface, buttons, and forms used for:
        i. Candidates to post new content on their websites
        ii. Users of the system to view candidate websites.
2. (Middle Layer) Controllers
    a. Client-Side Vote Encryption Utility: A cryptography component that is involved in encryption regarding votes.
    b. Pages Navigator and Layout Controller: A component that controls the layout of objects in the forms and websites viewed. In addition, it controls navigation requests from user interfaces.
    c. Conference Resources Controller: A component that controls the resources available for user to use in a debate. For example, mute/unmute microphone, etc.
    d. Message Encoder:
        i. Encodes all actions triggered by any other middle layer component to be sent to the server into appropriate messages to be sent.
        ii. Receives all messages from the server into actions that can be forwarded to any other middle layer component.
    e. Network Connections Controller: A component that receives/sends connection requests.
    f. Voting Authorization Key Controller: A component that carefully handles logic in regards to the authorization key to be received from the CLA.
    g. Pages editor: Allows candidates to edit their pages on the website.
3. (Bottommost Layer) Communication Utilities
    a. Message Sender: Takes encoded messages from Message Encoder (above) and uses network technologies to send them to the server.
    b. Message Receiver: Receives messages from server through network and forwards them to the Message Encoder.
    c. Communications SSL Encryption Utility: A cryptography component that is involved in encryption regarding sending/receiving messages on network securely.
    d. Downstream communication: Utility that helps downstream content and media.
    e. Upstream communication Utility that helps upstream content and media.

The server side consists of:

1. (Topmost Layer) Communication Utilities: The same as client side.
2. (Middle Layer) Controllers
    a. Message Encoder : Serves same purpose as client message encoder
    b. Page server: Controls the serving of layouts, forms, pages, and their content.
    c. CTF Services API: Contains the tools, functions, and classes that controls the CTF
    d. CLA Services API: Contains the tools, functions, and classes that controls the CLA
    e. Network Connections Controller: Serves same purpose as client connections controller.
    f. Debate controller: Overseas the control of debate rooms
    g. Authentication and Authorization Controller
3. (Bottommost Layer) Database Communication Utilities: Database APIs that allow the server controller to communicate with its databases.
    a. Connect/Disconnect from DB
    b. Push to DB: push new update to DB
    c. Pull from DB: copies specified content from DB
    d. Query DB

e. Backup DB

The databases needed by our system to function:

1. User profiles DB: This database contains records of all the system's users and their roles and authorizations. It also holds (encrypted) information needed to authenticate the users.
2. Election Votes DB: This database contains records of all ballots that were casted in the elections
3. CLA Authorization Keys DB: This database contains records of all the keys issued by CLA during voting.
4. Backups of DB: Database of database backups.

3.3 Design Rationale

This hybrid architecture was drawn to accumulate all advantages to three unique architectural patterns:

1- Client-Server architecture:

- By default, the architecture is a client-server.
- Clients are the voters and candidates. Server(s) are the voting system.
- This architecture enables the functions to be distributed across the network (Internet)
- In addition, some functions, such as vote encryption must happen with no interaction with our system and therefore that needs a specialized function on the client side.

2-MVC architecture:

- The views lie within the client portion of the application.
- Then there are layer of controllers spread across both client and server.
- The model (databases described above) lie in the servers of our system.
- This architecture enables easier maintenance and development could be split easier.
- In addition, views require emphasis on ease of use. While internal components require more emphasis on security and data integrity. The separation then allows focus on different non-functional requirements.

3- Layered Architecture:

- The system is developed and deployed as layers
- This facilitates the communications in the system where the interfaces can be fixed and each layer only deals with the one below it, not caring about changes in other layers.

4. DATA DESIGN

4.1 Data Description

In the data design, we follow an Object-Oriented (OO) approach. In this subsection, class diagrams for different subsystems are provided. In section 4.2., tables are presented to explain each entity. At the end of this section, the whole system is wrapped in one class diagram to explain the big picture.
(Clearer diagrams are in folder provided with submission).

4.1.0 EnV System (The Voting and Campaigning/Debating Subsystems)

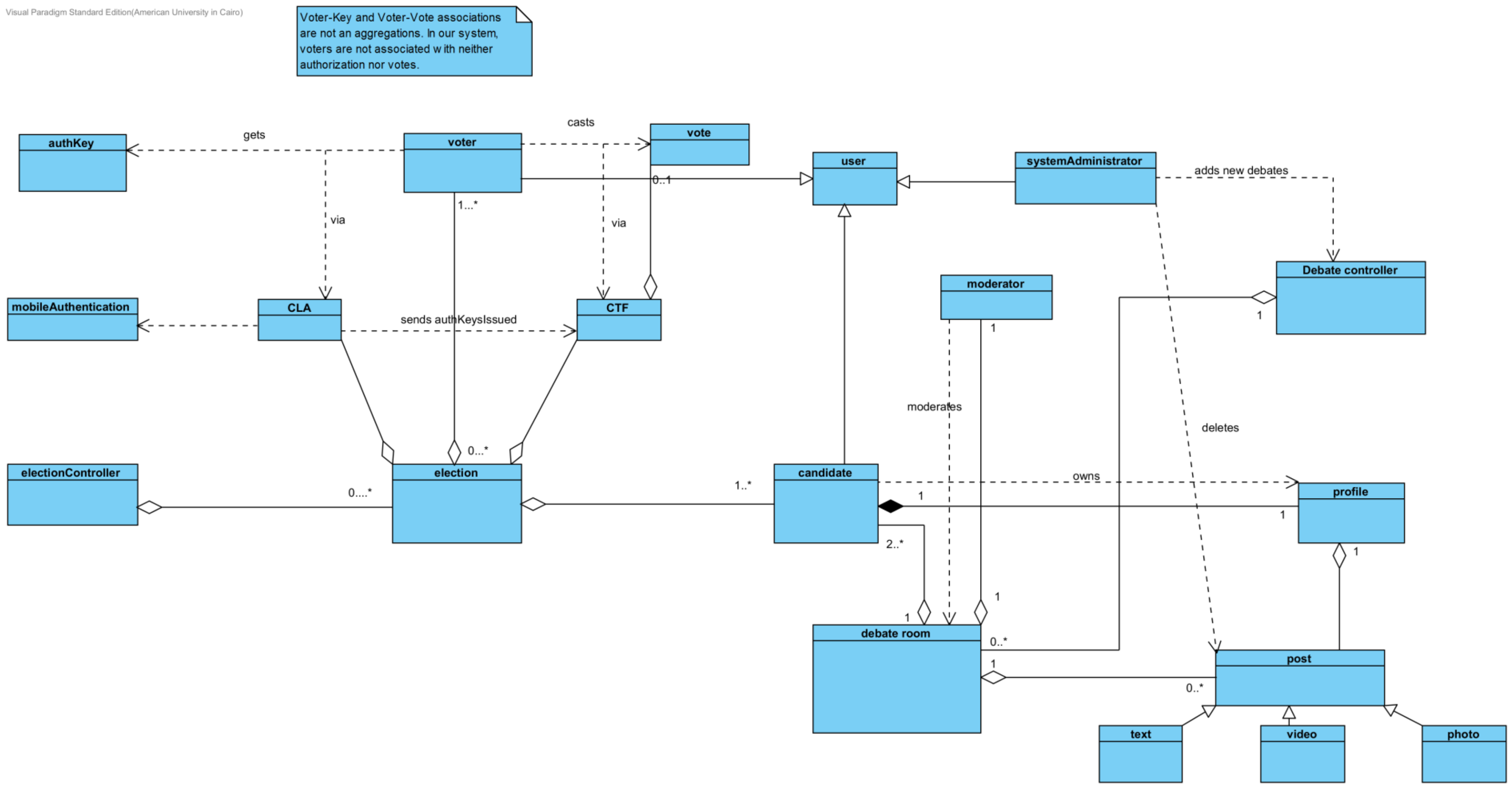
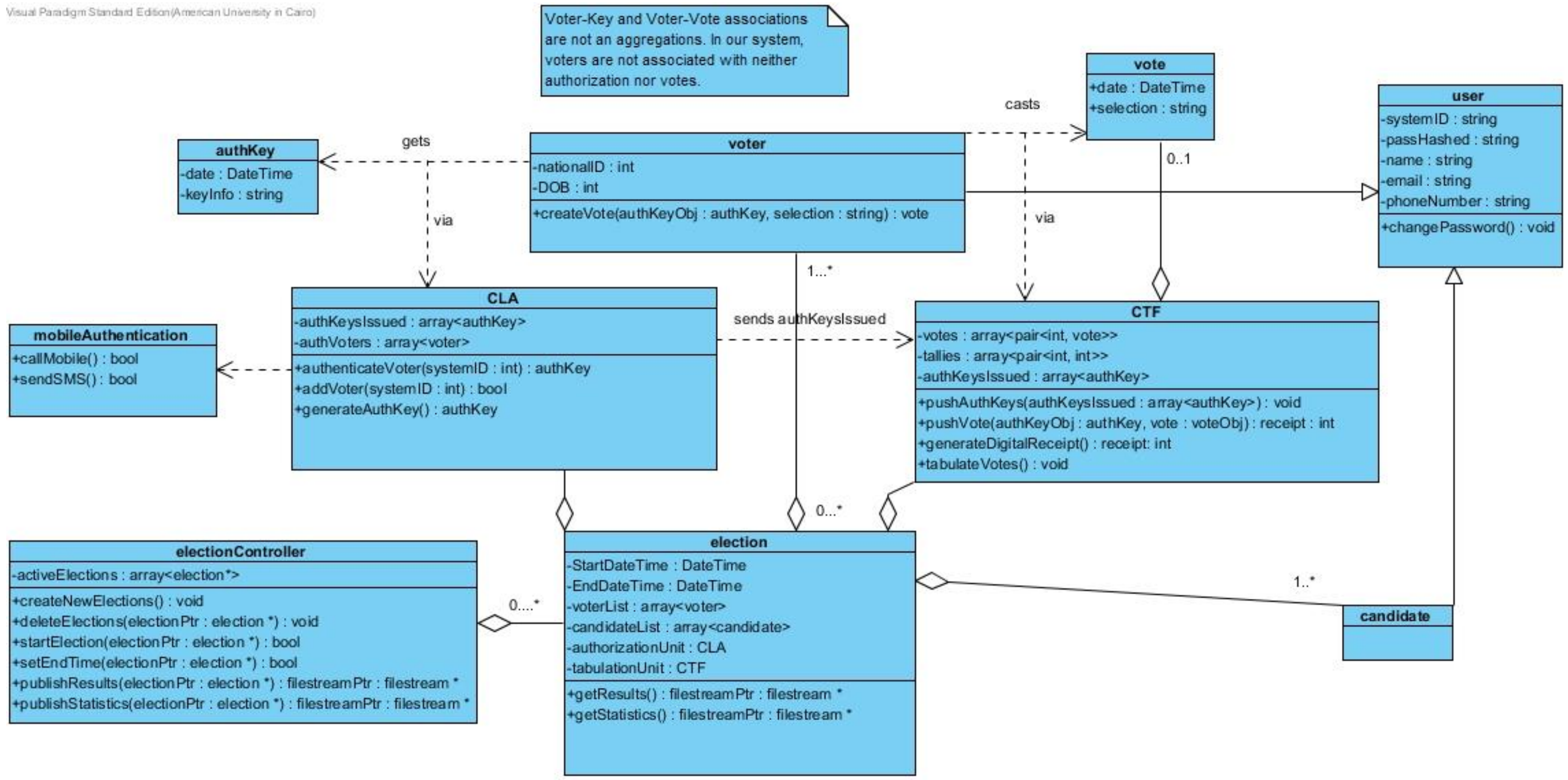


Figure 4.1.0: EnV class diagram

4.1.1 Voting Subsystem



Visual Paradigm Standard Edition(American University in Cairo)
Voter-Key and Voter-Vote associations are not an aggregations. In our system, voters are not associated with neither authorization nor votes.
vote
+date : DateTime
+selection : string
user
-systemID : string
-passHashed : string
-name : string
-email : string
-phoneNumber : string
+changePassword() : void
casts
gets
authKey
-date : DateTime
-keyInfo : string
voter
-nationalID : int
-DOB : int
+createVote(authKeyObj : authKey, selection : string) : vote
via
via
0..1
1...*
CLA
-authKeysIssued : array<authKey>
-authVoters : array<voter>
+authenticateVoter(systemID : int) : authKey
+addVoter(systemID : int) : bool
+generateAuthKey() : authKey
sends authKeysIssued
CTF
-votes : array<pair<int, vote>>
-tallies : array<pair<int, int>>
-authKeysIssued : array<authKey>
+pushAuthKeys(authKeysIssued : array<authKey>) : void
+pushVote(authKeyObj : authKey, vote : voteObj) : receipt : int
+generateDigitalReceipt() : receipt: int
+tabulateVotes() : void
mobileAuthentication
+callMobile() : bool
+sendSMS() : bool
0...*
electionController
-activeElections : array<election*>
+createNewElections() : void
+deleteElections(electionPtr : election *) : void
+startElection(electionPtr : election *) : bool
+setEndTime(electionPtr : election *) : bool
+publishResults(electionPtr : election *) : filestreamPtr : filestream *
+publishStatistics(electionPtr : election *) : filestreamPtr : filestream *
0....*
election
-StartDateTime : DateTime
-EndDateTime : DateTime
-voterList : array<voter>
-candidateList : array<candidate>
-authorizationUnit : CLA
-tabulationUnit : CTF
+getResults() : filestreamPtr : filestream *
+getStatistics() : filestreamPtr : filestream *
1..*
candidate

Figure 4.1.1: The voting system's class diagram

4.1.2 **Debating and Campaigning**

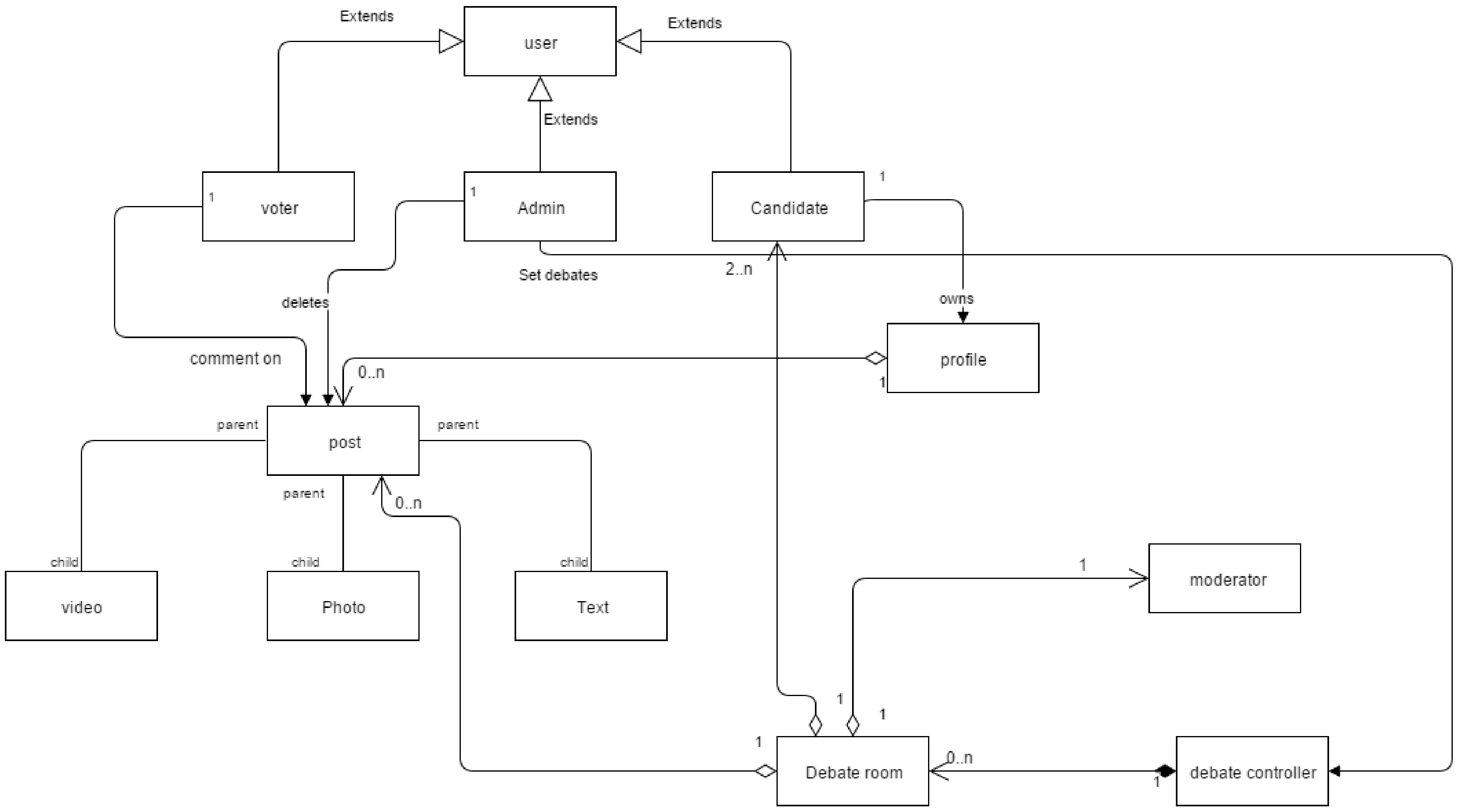
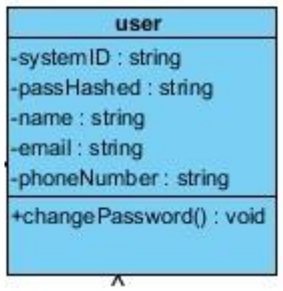


Figure 4.1.2: The debating system's class diagram

4.2 Data Dictionary

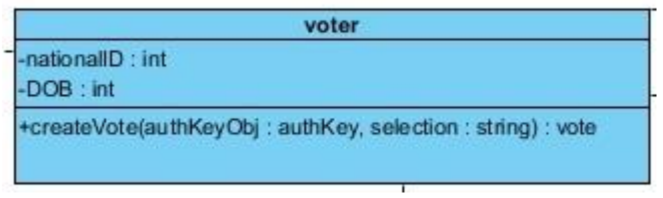
In this subsection, we list the structure including attributes and methods for each of the classes mentioned in section 4.1.



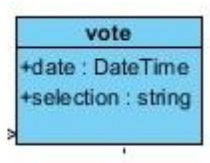
Class Name:	User
Brief Description:	That is the basic class for any user in the system. This class is the one that any other type of user inherits from; the admin, the candidate and the voter.
Attributes: (Fields):	**Attribute Description:**
systemID : string	The ID of the user logging in to the system
passHashed : string	Hash of user password
email : string	The email of the user to which all details will be sent.
phoneNumber : string	The phone numbr of the user to which mobile authentication would take place using.
Methods:	**Methods description**
changePassword() : void	Function that starts password changing process.
AccessSystem() : bool	Decides whether the user has the right to log in through an account to the system or not, and decides the type of access if he can log in.
viewPrevious (Debate room, profile)	This function allows the user to browse and view the old posts on profiles, or see old debates stored on the system.

Class Name:	Candidate
Brief Description:	This class represents the candidate in our system. This is not a voter class at all. In addition, it may represent individuals as well as parties. It inherits from “user”.
Attributes: (Fields):	**Attribute Description:**
profile : profile	The profile that the candidates creates for himself on the website.
Debate_in_action : Debate room	That is the debate room that the candidate is already using to debate with other candidate at the same time while users can see their debate live.
Methods:	**Method Description:**
Post_on_profile(posts)	The function that the candidate uses to post any content he desires on his profile on the website.
DeleteContent(posts)	The function that the candidate uses to delete any content he desires on his profile on the website.
getSlogan() : String	The function to get the slogan from the candidate.
setSlogan(slogan : String) : void	This function sets the slogan that the candidate has decided before on the profile.
getNumber() : integer	The function to get the number from the candidate.
setNumber(number : integer) : void	This function sets the number that the candidate has decided before on the profile.
getName() : String	The function to get the name from the candidate.
setName(name : String) : void	This function sets the name that the candidate has decided before on the profile.
getDebate_in_action() : Debate room	This function is used to create a debate room for the candidate to participate in.

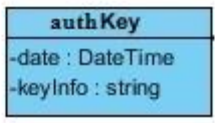
setDebate_in_action(Debate_in_action : Debate room) : void	This function sets the debate room called debate_in_action for the candidate.
post_in_Debate() : bool	The function that allows the candidate to participate in debate, and returns whether it is possible or not.
payForAds_onSocialMedia(Posts, string : slogan)	This function allows the candidate to post his posts on social media too and then charges him for that campaigning.
complain_aboutOtherCandidate(Posts, System Administrator)	This function allows the candidate to complain about other candidates posts to the system administrator.
campaign_allowed(System Administrator) : bool	This function returns whether campaigning is allowed by the system administrator or not at that time.


voter
-nationalID : int
-DOB : int
+createVote(authKeyObj : authKey, selection : string) : vote

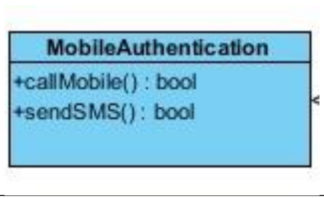
Class Name:	voter
Brief Description:	Class for voter representation inside system. Inherits from “user” class.
Attributes: (Fields):	**Attribute Description:**
nationalID : int	National ID of voter
DOB : int	Date of Birth of voter
Favorite candidate : string	This attribute saves the voter’s favorite candidate in order to have his news all the time.
Methods:	**Methods description**
createVote (authKeyObj : authKey , selection : string) : vote shareOnSocialMedia(posts, candidate)	Essential function so that the voter can create a vote ready to be pushed to the CTF This method allows the voter to share anything related to a candidate from his profile to social media.



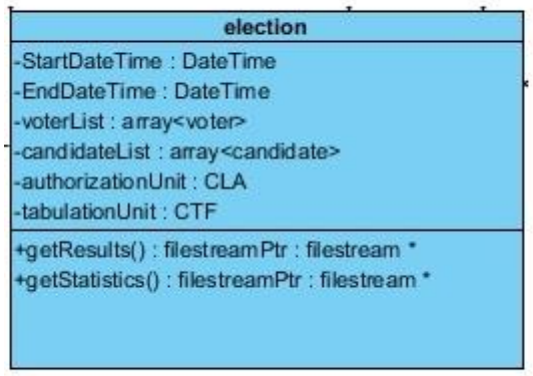
Class Name:	vote
Brief Description:	Class for voter representation inside system. Inherits from “user” class.
Attributes: (Fields):	**Attribute Description:**
date : DateTIme	Date and time of vote creation
selection : string	Vote information about choice in election



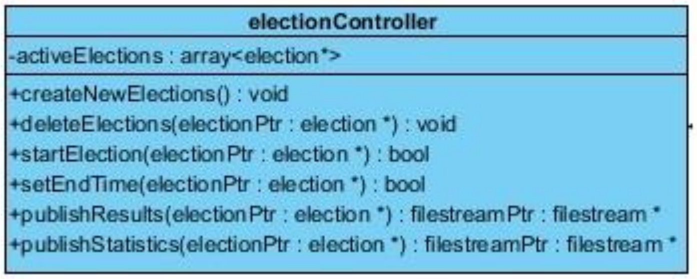
Class Name:	authKey
Brief Description:	Class for authorization key representation inside system.
Attributes: (Fields):	**Attribute Description:**
date : DateTime	Date and time of key issuing
keyInfo : string	Information of the key



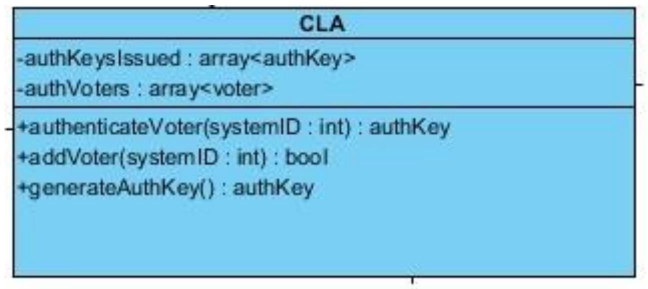
Class Name:	mobileAuthentication
Brief Description:	Utility class for mobile authentication purposes
Methods:	**Methods description**
callMobile() : bool	Verification call to voter’s phoneNumber
sendSMS() : bool	Send verification SMS to voter’s phoneNumber


election
-StartDateTime : DateTime
-EndDateTime : DateTime
-voterList : array<voter>
-candidateList : array<candidate>
-authorizationUnit : CLA
-tabulationUnit : CTF
+getResults() : filestreamPtr : filestream *
+getStatistics() : filestreamPtr : filestream *

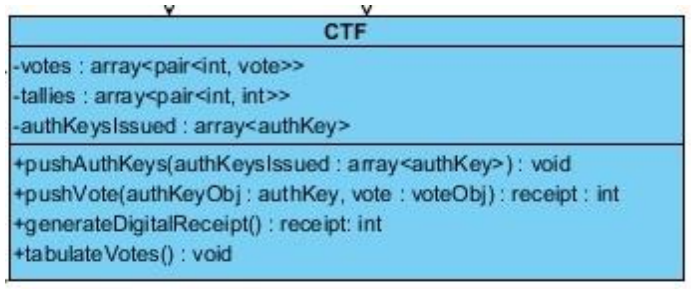
Class Name:	election
Brief Description:	Class to represent an election inside the system
Attributes: (Fields):	**Attribute Description:**
StartDateTime : DateTime	The date and time of elections start
EndDateTime : DateTime	The date and time of elections end
voterList : array < voter ?	Array of eligible voters in an election
phoneNumber : string	The phone numbr of the user to which mobile authentication would take place using.
Methods:	**Methods description**
getResults () : filestreamPtr : filestream*	Communciates with CTF to get results, returns a file output
getStatistics () : filestreamPtr : filestream*	Creates statistics about elections, returns a file output


electionController
-activeElections : array<election*>
+createNewElections() : void
+deleteElections(electionPtr : election *) : void
+startElection(electionPtr : election *) : bool
+setEndTime(electionPtr : election *) : bool
+publishResults(electionPtr : election *) : filestreamPtr : filestream *
+publishStatistics(electionPtr : election *) : filestreamPtr : filestream *

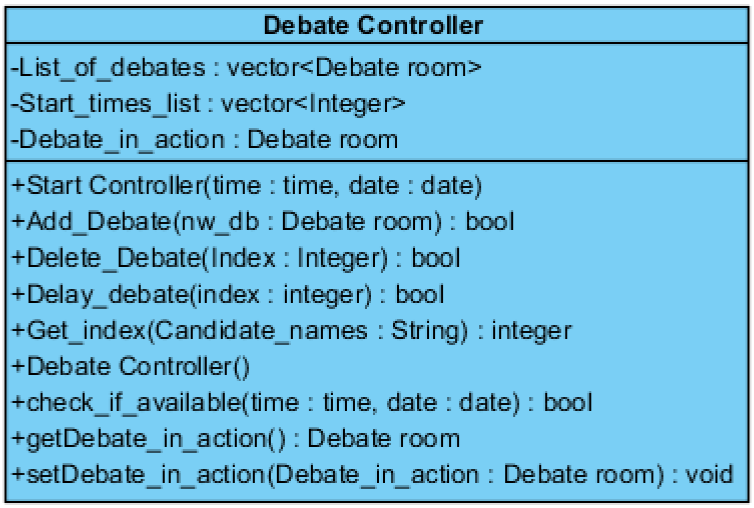
Class Name:	electionController
Brief Description:	Class to represent elections controller. May control more than one concurrent election.
Attributes: (Fields):	**Attribute Description:**
activeElections : array <election*>	Array of all active elections
Methods:	**Methods description**
creatNewElections() : void	Creates new elections
deleteElections (electionPtr : election*) : void	Delete a certain election
startElection (electionPtr : election*) : bool	Start a certain election
setEndTime (electionPtr : election*) : bool	Set the end time of a certain election
publishResults (electionPtr : election*) : filestreamPtr : filestream*	Publish results of a certain election
publishStatistics (electionPtr : election*) : filestreamPtr : filestream*	Publish statistics of a certain election


CLA
-authKeysIssued : array<authKey>
-authVoters : array<voter>
+authenticateVoter(systemID : int) : authKey
+addVoter(systemID : int) : bool
+generateAuthKey() : authKey

Class Name:	CLA
Brief Description:	Central Legitimacy Agency (description as described in the document)
Attributes: (Fields):	**Attribute Description:**
authKeysIssued : array <authKey>	Array of all keys issues.
authVoters : array <voter >	Array of all voters who took keys.
Methods:	**Methods description**
authenticateVoter (systemId : string) : authKey	Essential function that authenticates a voter before voting and send him an authKey (if eligible to vote)
addVoter (systemID : int) : bool	Function that adds a certain voter to authVoters
generateAuthKey() : authKey	Utility function that generates a unique random authKey each invocation

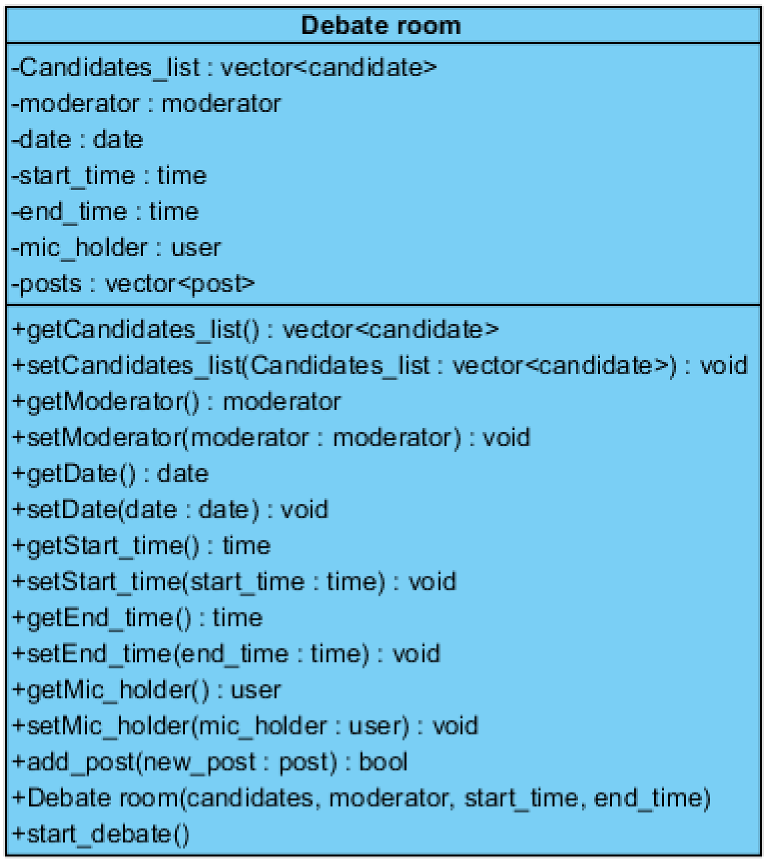

CTF
-votes : array<pair<int, vote>>
-tallies : array<pair<int, int>>
-authKeysIssued : array<authKey>
+pushAuthKeys(authKeysIssued : array<authKey>) : void
+pushVote(authKeyObj : authKey, vote : voteObj) : receipt : int
+generateDigitalReceipt() : receipt: int
+tabulateVotes() : void

Class Name:	CTF
Brief Description:	Central Tabulating Facility (description as described in the document)
Attributes: (Fields):	**Attribute Description:**
votes : array <pair <int, vote>>	Array of pairs of receipts and votes to store votes information before tallying
tallies : array < pair<int, int>>	Array of pairs of election choice number and number of votes for that choice
authKeysIssued : array <authKey>	same as CLA (actually copied from there)
Methods:	**Methods description**
pushAuthKey (authKeysIssued : array <authKey>) : void	Utility function that CLA uses to push the issued keys to the CTF
pushAuthKey (authKeyObj : authKey , voteObj : vote) receipt : int	Voter uses this function to push his vote to the CF, return a digital receipt for the voter
generateDigitalReceipt () : receipt : int	Utility function that generates a unique random receipt each invocation
tabulateVotes() : void	Utility function that calculates tallies after voting is complete


Debate Controller
-List_of_debates : vector<Debate room>
-Start_times_list : vector<Integer>
-Debate_in_action : Debate room
+Start Controller(time : time, date : date)
+Add_Debate(nw_db : Debate room) : bool
+Delete_Debate(Index : Integer) : bool
+Delay_debate(index : integer) : bool
+Get_index(Candidate_names : String) : integer
+Debate Controller()
+check_if_available(time : time, date : date) : bool
+getDebate_in_action() : Debate room
+setDebate_in_action(Debate_in_action : Debate room) : void

Class Name:	Debate controller
Brief Description:	This class acts as a container for all the planned debates. It makes sure that no time clashes exist between debates and it will start and end the debates on the planned time without external intervention. Only the Admin can access this class.
Attributes: (Fields):	**Attribute Description:**
-List_of_debates : vector<Debate room>	A list of all created debates that will happen.
-Debate_in_action : Debate room	The Debate that is taking place in current time, only one debate can take place on a given time.
-Start_times_list : vector<Integer>	A sorted list of the start times of debates.
Methods:	**Method Description:**
+Add_Debate(nw_db : Debate room) : bool	The admin uses this method to add a new debate to the schedule. It takes a Debate room object as a parameter then checks if its time is free and if so, it adds it to the “List of debates” and the “start time list” then returns true, otherwise it returns false.
+Delete_Debate(Index : Integer) : bool	The admin can delete a scheduled debate using this method. It takes the index of the debate to be

	deleted, checks if it exists, deletes it and returns true if found, returns false otherwise.
+Delay_debate(index : integer) : bool	The admin can delay a scheduled debate using this method. It takes the index of the debate to be delayed, checks if it exists, checks that there is no time clash for the new time delays it and returns true if no clash exists, returns false otherwise.
+Get_index(Candidate_names : String) : integer	Returns the index of the debate given the name of candidates debating
+check_if_available(time : time, date : date) : bool	Checks if there is a debate scheduled in a given time and date, returns true if the time is free, false otherwise.
+setDebate_in_action(Debate_in_action : Debate room) : void	A setter for “Debate_in_action” called by the “start_controller” method if the debate starts.
+Start Controller(time : time, date : date)	This method acts as an internal clock, it checks every minute if a debate should start now or not. If a debate should start, the method calls the “start debate” method of the Debate room object. The method has to be called once by the admin after adding all the debates and should take the current time and date as a parameter



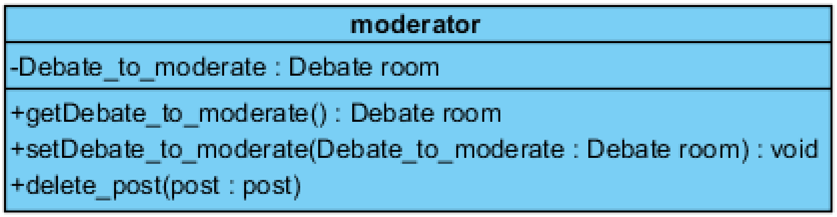
Debate room

-Candidates_list : vector<candidate>
-moderator : moderator
-date : date
-start_time : time
-end_time : time
-mic_holder : user
-posts : vector<post>

+getCandidates_list() : vector<candidate>
+setCandidates_list(Candidates_list : vector<candidate>) : void
+getModerator() : moderator
+setModerator(moderator : moderator) : void
+getDate() : date
+setDate(date : date) : void
+getStart_time() : time
+setStart_time(start_time : time) : void
+getEnd_time() : time
+setEnd_time(end_time : time) : void
+getMic_holder() : user
+setMic_holder(mic_holder : user) : void
+add_post(new_post : post) : bool
+Debate room(candidates, moderator, start_time, end_time)
+start_debate()

Class Name:	Debate room
Brief Description:	This class models a Debate, its attributes, the methods that operates on them.
Attributes: (Fields):	**Attribute Description:**
-Candidates_list : vector<candidate>	A list of the candidates debating.
-moderator : moderator	The moderator of this debate.
-date : date	The date for the debate.
-start_time : time	The planned starting time of the debate.
-end_time : time	The time in which the debate ends.
-mic_holder : user	The user that can post on the debate in any given time. Only one user (candidate, moderator) can post at any given time.
-posts : vector<post>	a list of posts made by the users in this debate room.

Methods:	**Method Description:**
+getCandidates_list() : vector<candidate>	Returns the candidate list in this debate room.
+setCandidates_list(Candidates_list : vector<candidate>) : void	This method is called to set the “candidate_list” : the candidates will be debating in this room.
+getModerator() : moderator	Returns the moderator in this debate room.
+setModerator(moderator : moderator) : void	Used to set or change the moderator of the debate.
+getDate() : date	Returns the date of the debate.
+setDate(date : date) : void	Sets the date of the debate.
+getStart_time() : time	Returns the starting time of this debate.
+setStart_time(start_time : time) : void	Sets the starting time of this debate.
+getEnd_time() : time	Returns the end time of the debate.
+setEnd_time(end_time : time) : void	Sets the end time of the debate.
+getMic_holder() : user	Returns the user that is allowed to post in that in a given time.
+setMic_holder(mic_holder : user) : void	Sets the user allowed to post in this debate room.
+add_post(new_post : post, caller :user) : bool	This method is called to post a new post (text, video or a photo) in this debate room. The method checks if this user is the mic holder, places the new post and returns true, otherwise it returns false and tells the user that he is not allowed to post at this moment.
+ view() : vector<post>	Returns the posts that have been posted in the debate room.
+start_debate()	The trigger for starting the debate, it calls “setDebate_in_action” for the candidates in this room and “setDebate_to_moderate” for the moderator to give them access to the room.

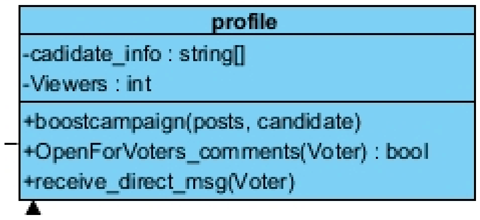


moderator

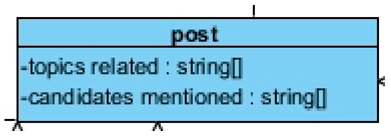
-Debate_to_moderate : Debate room

+getDebate_to_moderate() : Debate room
+setDebate_to_moderate(Debate_to_moderate : Debate room) : void
+delete_post(post : post)

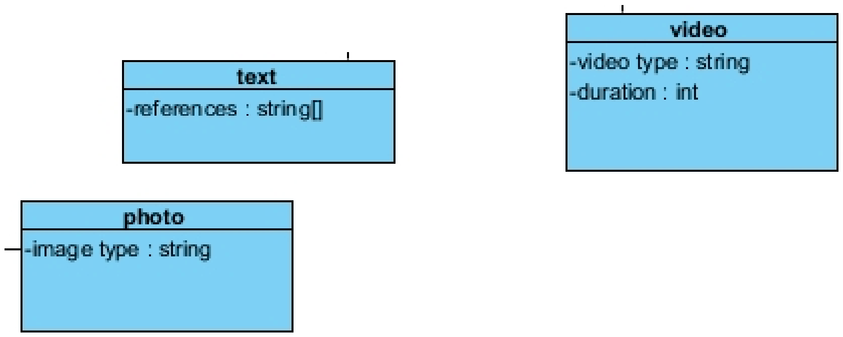
Class Name:	moderator
Brief Description:	This class models the moderator for a debate, his attributes and methods.
Attributes: (Fields):	**Attribute Description:**
Debate_to_moderate : Debate room	The debate room in which this moderator is moderating.
Methods:	**Method Description:**
getDebate_to_moderate() : Debate room	Returns the debate room in which he is a moderator.
setDebate_to_moderate(Debate_to_moderate : Debate room) : void	Sets debate room in which he is a moderator. This method is called by “start_debate” in the debate room class.
Delete_post(post : post)	The moderator can delete a post in the debate room using this method.


profile
-cadidate_info : string[]
-Viewers : int
+boostcampaign(posts, candidate)
+OpenForVoters_comments(Voter) : bool
+receive_direct_msg(Voter)

Class Name:	Profile
Brief Description:	That is the class controlling the candidate’s profile
Attributes: (Fields):	**Attribute Description:**
Candidate_info: string[]	This array of strings include all the information that the candidate wishes to post about himself on the website.
Viewers : int	That is the number of viewers and visitors who accessed the profile to know more about the candidate.
Methods:	**Methods Description**
getCandidate_info(candidate) : string []	This function is responsible for getting all the information of the candidate who owns the profile.
setCandidate_info(candidate_info : string []) : void	That is the function used to the data that the candidate has already given about himself.
boostcampaign(posts, candidate)	That is a function used by the user to boost all his post once at a time on the website and social media if he deserves, for increased exposure to voters.
OpenForVoters_comments(Voter) : bool	This function indicates whether voters can comment or not
receive_direct_msg(Voter)	This function allows voters to send direct messages to candidates directly through their profiles.



Class Name:	Post
Brief Description:	The Posts class is responsible for the posts that will be posted by the candidate on his profile, different types of posts as text, video and images inherit from it.
Attributes: (Fields):	**Attribute Description:**
Topics related : string[]	This array includes all the topics that a single post would contain or all people he will mention.
Candidates mentioned : string[]	The unique number of the candidate used in the elections.



Class Name:	Text
Brief Description:	The class text is a type of post that inherits from the class posts all its features.
Attributes: (Fields):	**Attribute Description:**
Refrences : string[]	This array includes all the references the text has included.

Class Name:	Video
Brief Description:	The class video is a type of post that inherits from the class posts all its features.
Attributes: (Fields):	**Attribute Description:**
Video type : string	This attribute stores the type of the video.
Video duration : int	The attribute that stores the duration of the video.

Class Name:	Photo
Brief Description:	The class photos is a type of post that inherits from the class posts all its features.
Attributes: (Fields):	**Attribute Description:**
Image type : string	This attribute stores the type of the image.

5. Dynamic Model

This section demonstrates the interaction between system's components. We illustrate the dynamic interaction using the sequence diagrams below.

5.1. Sequence Diagrams

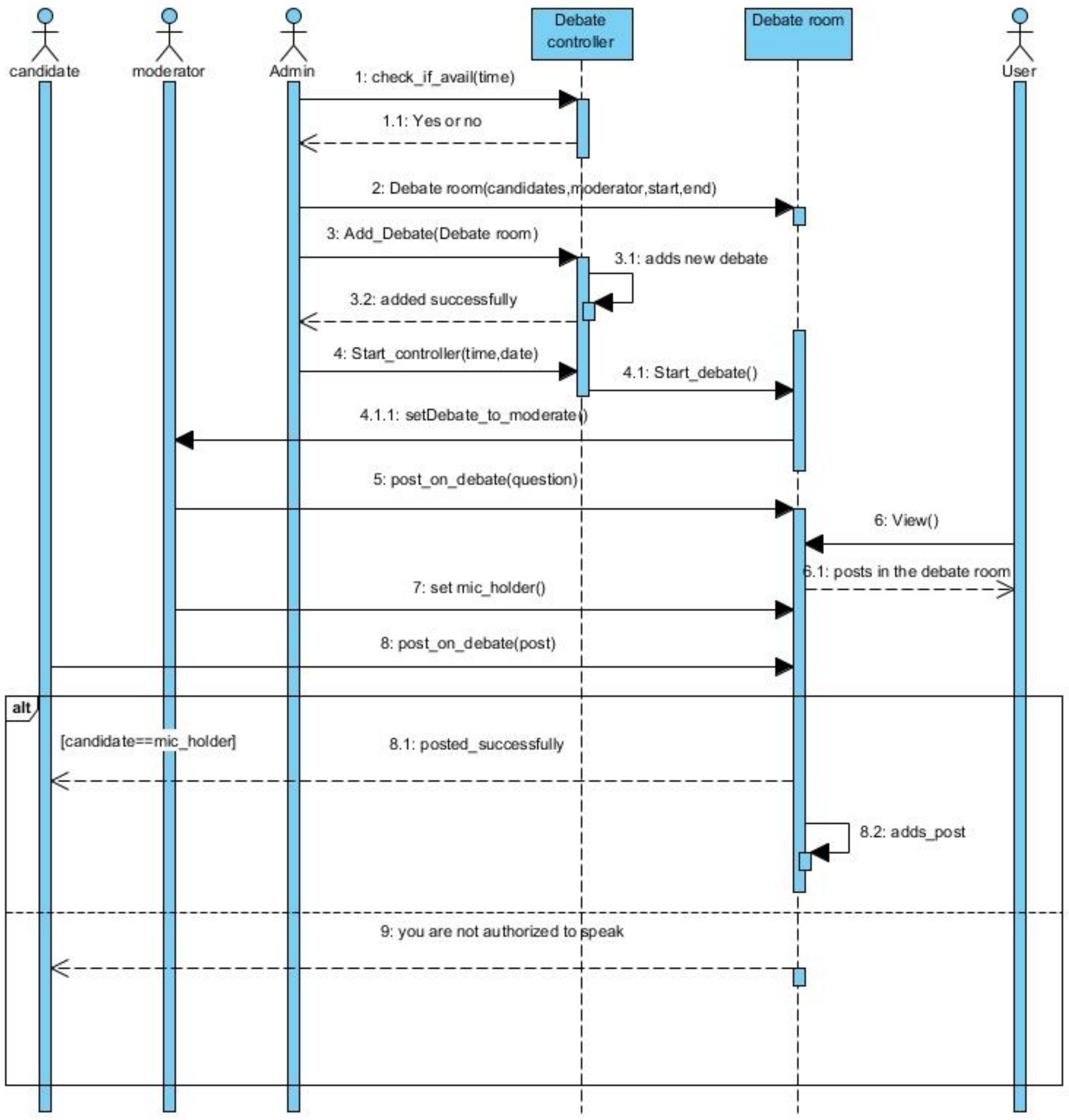


Figure 5.1: Sequence diagram for the debating process

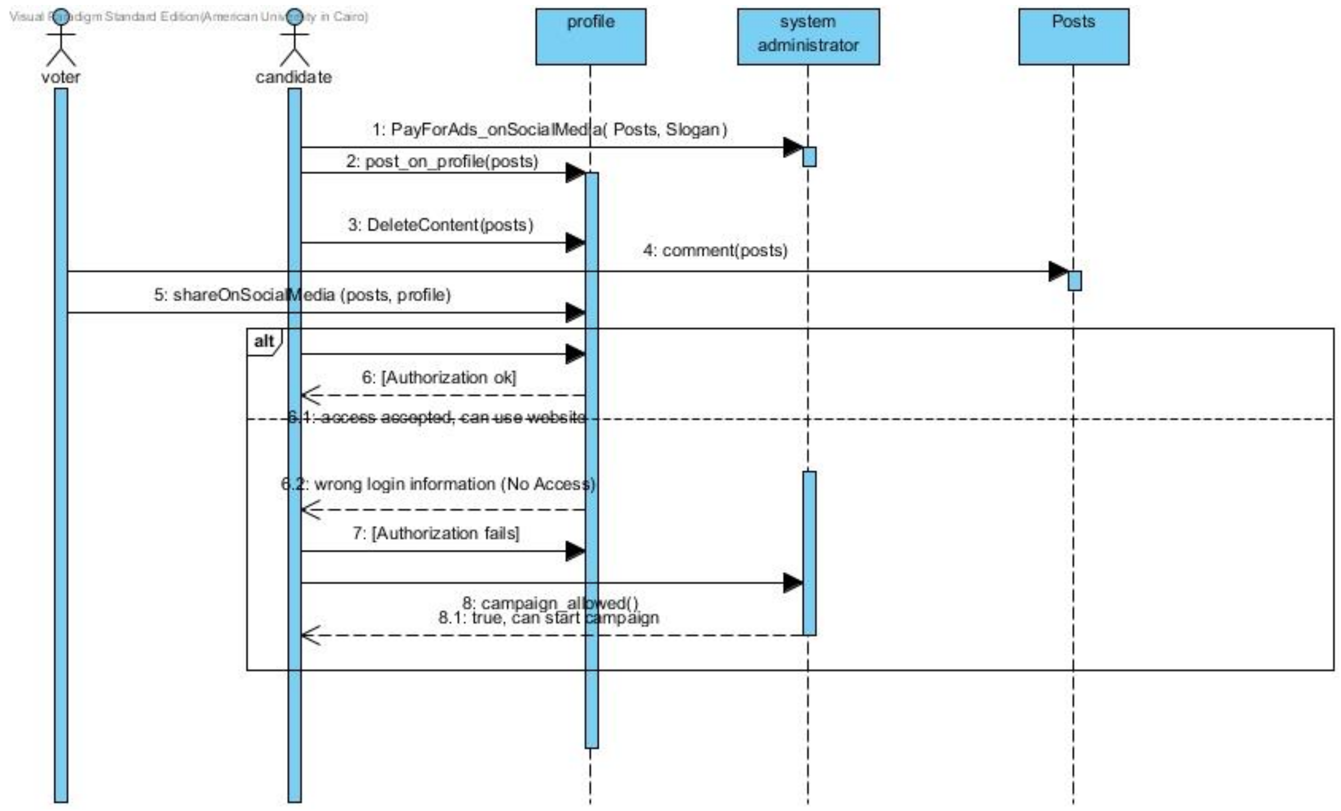

Visual Paradigm Standard Edition(American University in Cairo)
voter
candidate
profile
system administrator
Posts
1: PayForAds_onSocialMedia(Posts, Slogan)
2: post_on_profile(posts)
3: DeleteContent(posts)
4: comment(posts)
5: shareOnSocialMedia (posts, profile)
alt
6: [Authorization ok]
6.1: access accepted, can use website
6.2: wrong login information (No Access)
7: [Authorization fails]
8: campaign_allowed()
8.1: true, can start campaign

Figure 5.2: Sequence Diagram for the campaigning process

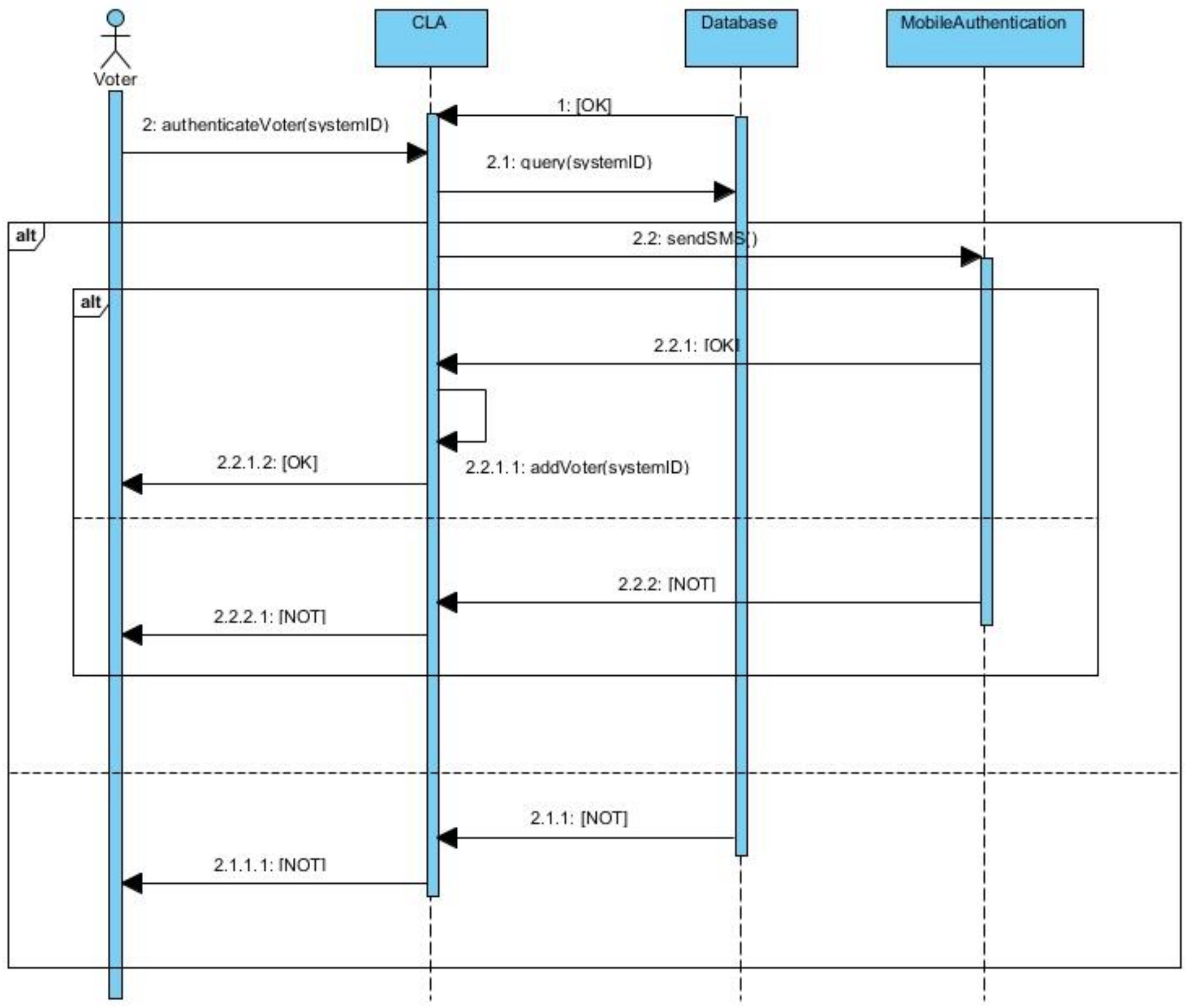


Figure 5.3: The authentication process before the voting

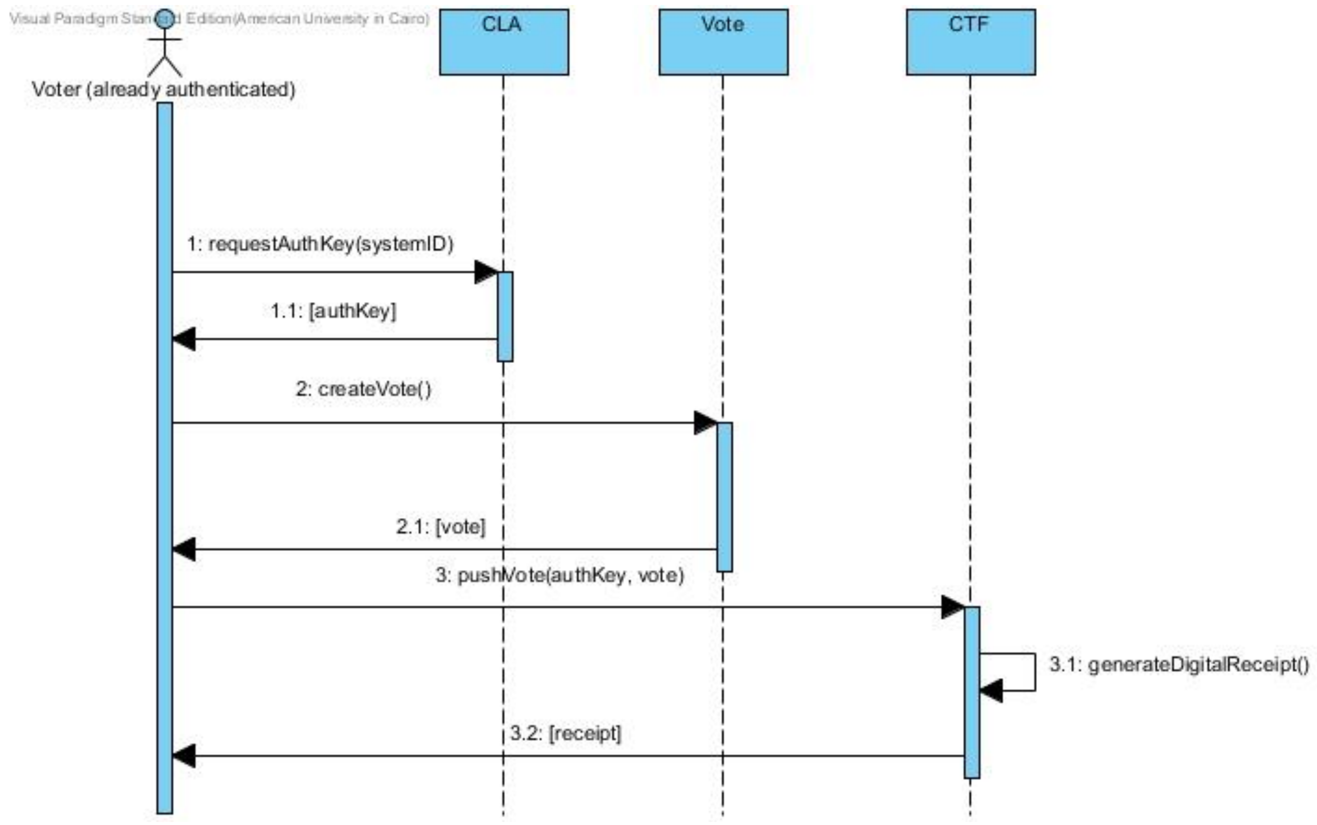

Visual Paradigm Standard Edition(American University in Cairo)
CLA
Vote
CTF
Voter (already authenticated)
1: requestAuthKey(systemID)
1.1: [authKey]
2: createVote()
2.1: [vote]
3: pushVote(authKey, vote)
3.1: generateDigitalReceipt()
3.2: [receipt]

Figure 5.4: Overview of the voting process

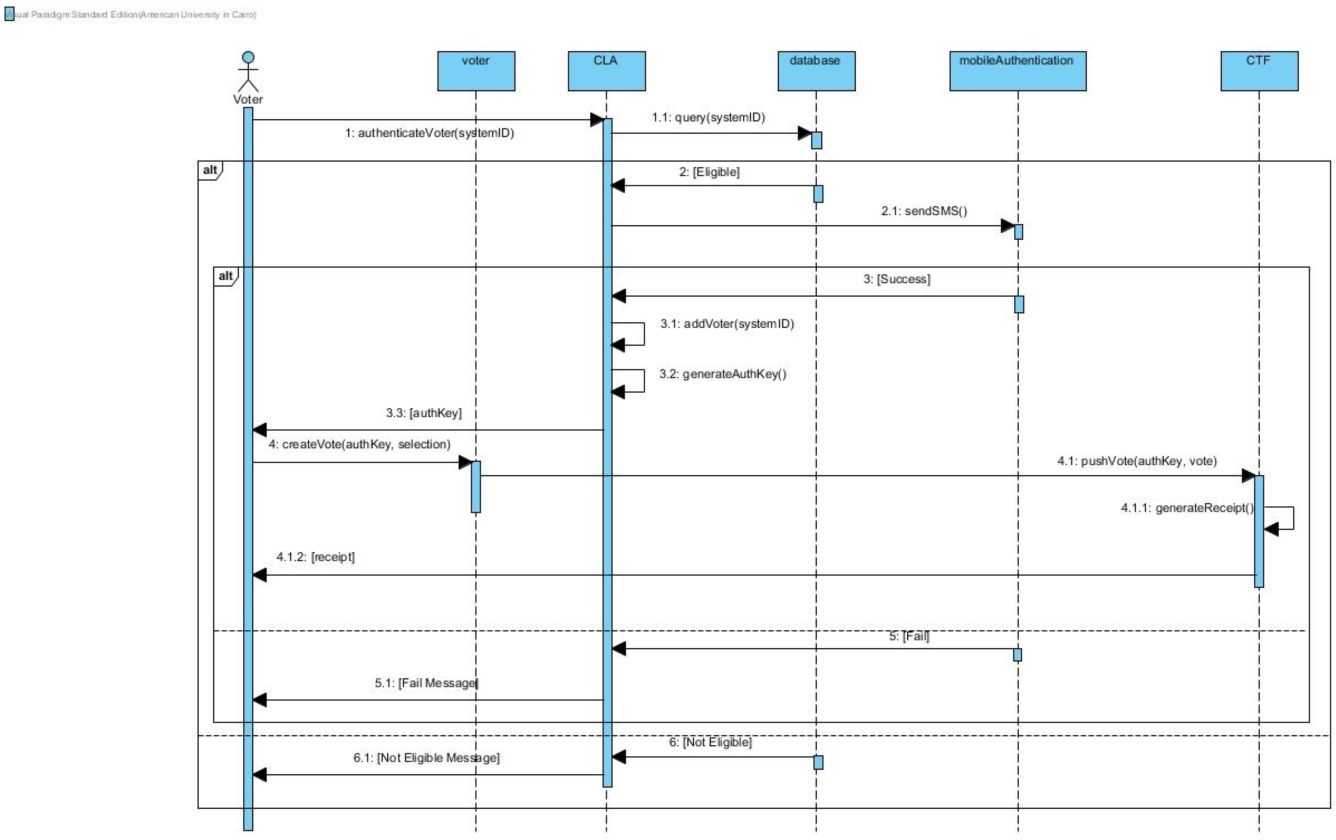


Figure 5.5: Detailed explanation of the voting process

6. Human Interface Design

6.1 Overview of User Interface

The user interface in this system is very important because it will allow the voters, candidates and trustees to interact with the system to do the most important functionalities. In this section, we divide the UI into five sections; voting, debating, campaigning, accounting and configuration. In this subsection, we explain the interface benefits for each of the system users.

Note:
The interface prototype has been provided more functions and is better viewed through these two links.
https://moqups.com/islamfm@aucegypt.edu/ZNnbnCcQ/
https://moqups.com/islamfaisal@i2msoft.com/3CXSPvNG/

Remark 6.1.1. We omit a user interface for the system admins here. System admins will use a combination of the operating system's environment and an already existing DBMS.

6.1.1. Voter

The voter should be able to use the interface to register, vote and verify the elections results. The voter should also be able to view the contents of debates and campaigns.

6.1.2. Candidate

The candidate should be able to use the interface to publish content related to their campaign, join and participate in debates.

6.1.3. Trustee

The trustee's UI should enable them to setup elections and configure their type, starting and ending time.

6.1.4. Debate Moderator

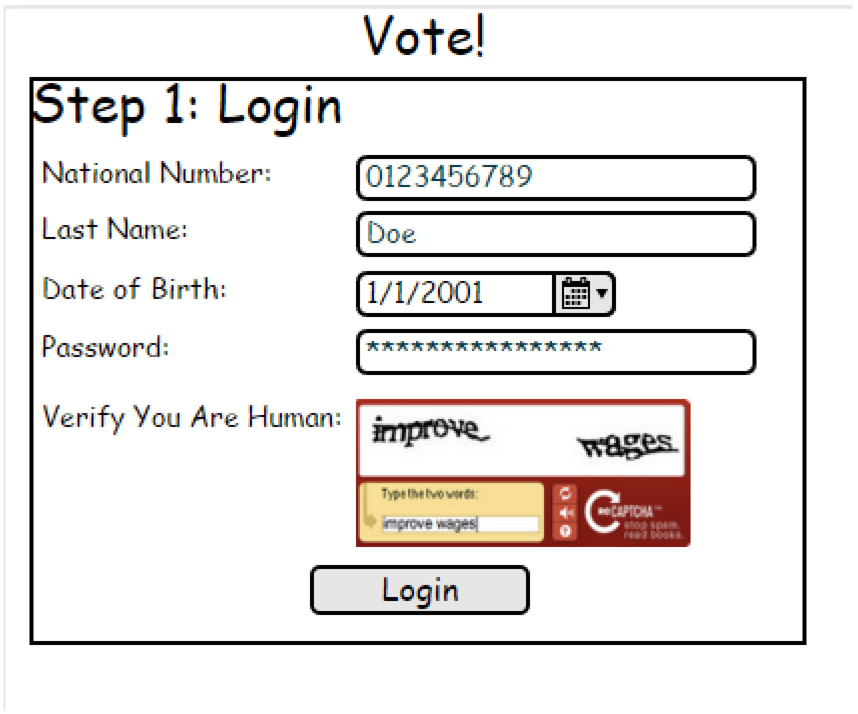
The debate moderator's UI should be enable them to join and manage properly a debate session by granting resources such as mic, camera, receive questions from the public and block users.

6.2 Screen Images

This section contains an outline of the expected UI for each module of the system.

6.2.1. Login

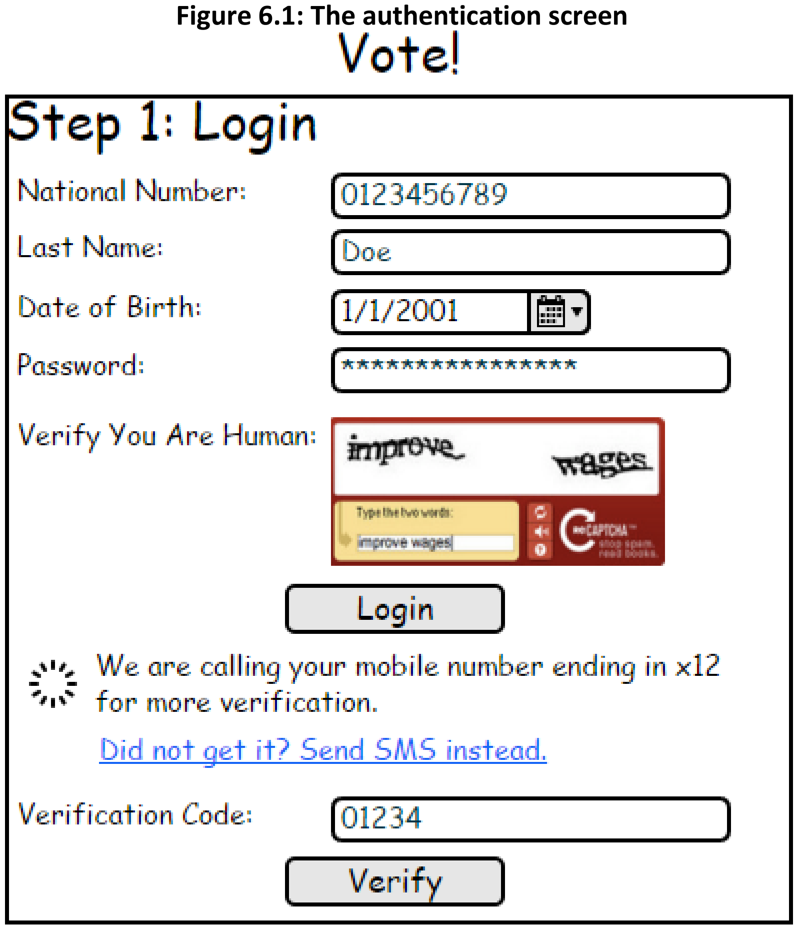
Figures 6.1 and 6.2 demonstrate the 2-factor authentication process.


Vote!

Step 1: Login

National Number:	0123456789
Last Name:	Doe
Date of Birth:	1/1/2001
Password:	****************
Verify You Are Human:	improve wages

Figure 6.1: The authentication screen


Vote!

Step 1: Login

National Number:	0123456789
Last Name:	Doe
Date of Birth:	1/1/2001
Password:	****************
Verify You Are Human:	improve wages

We are calling your mobile number ending in x12 for more verification.

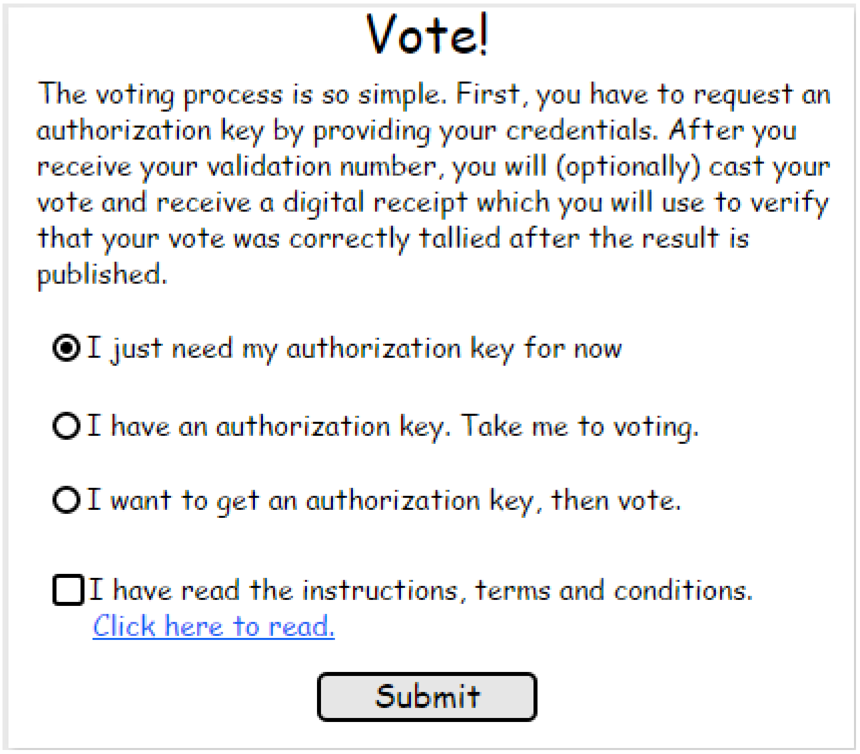
Did not get it? Send SMS instead.

Verification Code:	01234

Figure 6.2: The prompt for mobile-authentication screen

6.2.2. Voting

This is the most essential and vital part of the system. This is the part where the voter (our main user) will interact with the system to cast their vote. Figures 6.3 through 6.5 provide a glimpse of how the voting process will look like.



Vote!

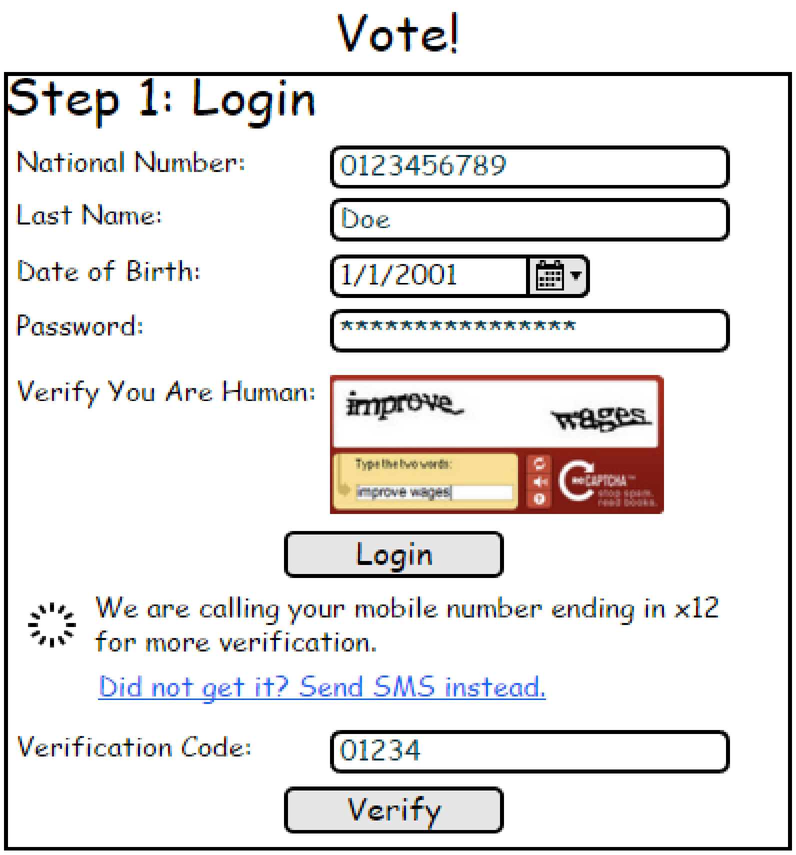
The voting process is so simple. First, you have to request an authorization key by providing your credentials. After you receive your validation number, you will (optionally) cast your vote and receive a digital receipt which you will use to verify that your vote was correctly tallied after the result is published.

- ◉ I just need my authorization key for now
- ○ I have an authorization key. Take me to voting.
- ○ I want to get an authorization key, then vote.

☐ I have read the instructions, terms and conditions. Click here to read.

Figure 6.3: The first step in the voting process

To request an authorization key, the user needs to use the login interface in figure 6.2.


Vote!

Step 1: Login

National Number:	0123456789
Last Name:	Doe
Date of Birth:	1/1/2001
Password:	****************
Verify You Are Human:	improve wages

Type the two words: improve wages

Login

We are calling your mobile number ending in x12 for more verification.

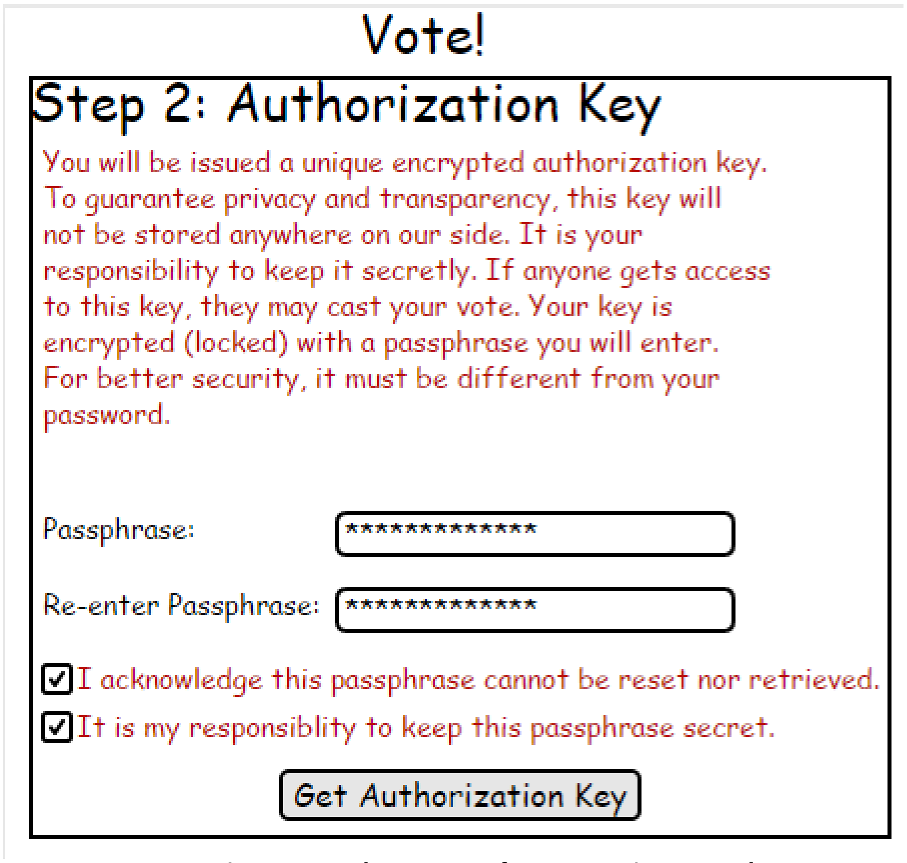
Did not get it? Send SMS instead.

Verification Code:	01234

Verify

Figure 6.2: The prompt for mobile-authentication screen

After that the user enters a passphrase to encrypt his authorization key.



Vote!

Step 2: Authorization Key

You will be issued a unique encrypted authorization key. To guarantee privacy and transparency, this key will not be stored anywhere on our side. It is your responsibility to keep it secretly. If anyone gets access to this key, they may cast your vote. Your key is encrypted (locked) with a passphrase you will enter. For better security, it must be different from your password.

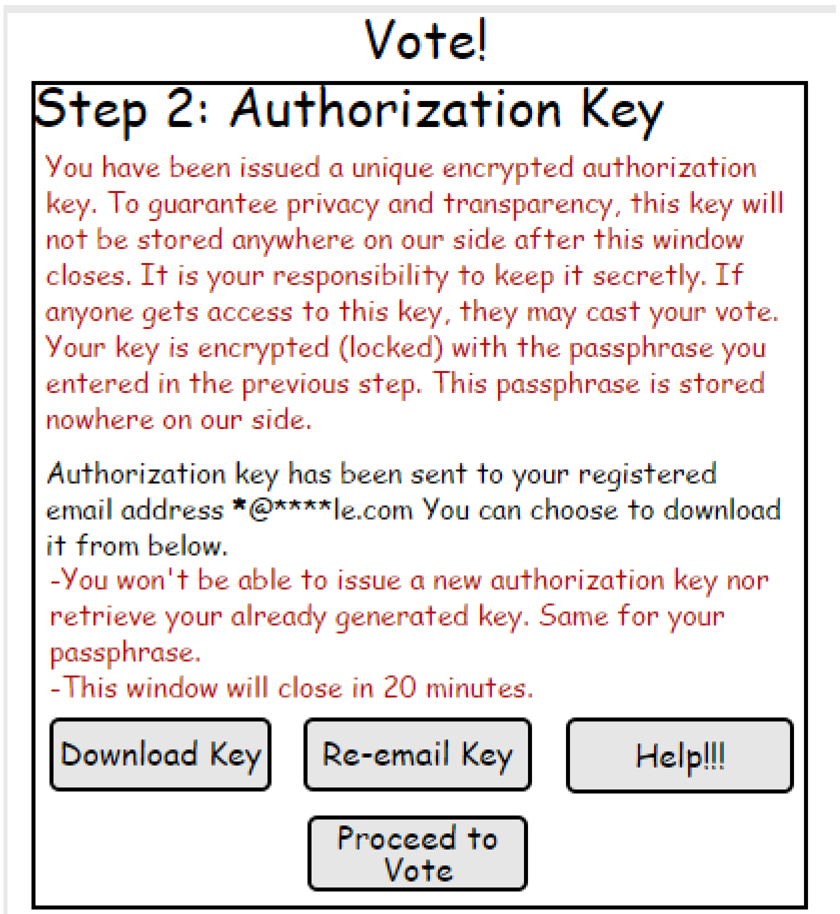
Passphrase:	*************
Re-enter Passphrase:	*************

☑ I acknowledge this passphrase cannot be reset nor retrieved.

☑ It is my responsiblity to keep this passphrase secret.

Figure 6.4: The prompt for encryption passphrase

After that depending on the given authorization information, the user is redirected to a a page to tell him whether he made a successful authorization.

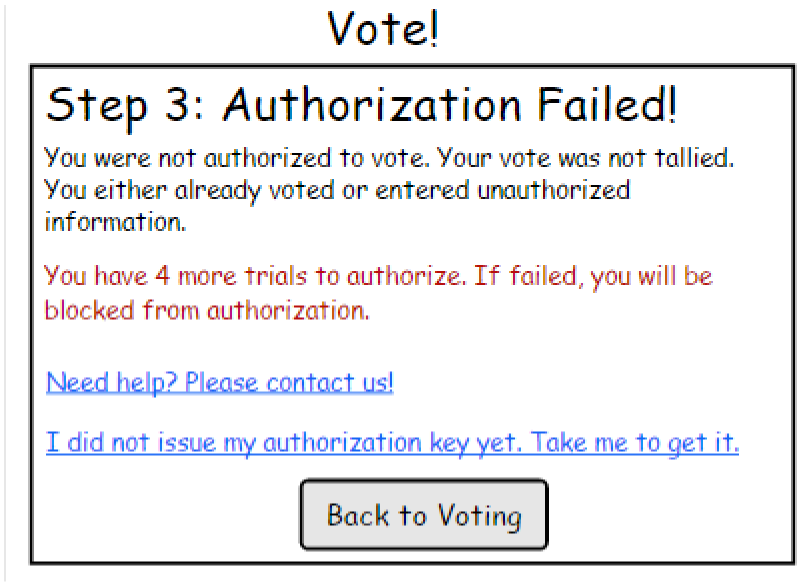

Vote!

Step 2: Authorization Key

You have been issued a unique encrypted authorization key. To guarantee privacy and transparency, this key will not be stored anywhere on our side after this window closes. It is your responsibility to keep it secretly. If anyone gets access to this key, they may cast your vote. Your key is encrypted (locked) with the passphrase you entered in the previous step. This passphrase is stored nowhere on our side.

Authorization key has been sent to your registered email address *@****le.com You can choose to download it from below.
-You won't be able to issue a new authorization key nor retrieve your already generated key. Same for your passphrase.
-This window will close in 20 minutes.

Figure 6.5: A successful authorization notification


Vote!

Step 3: Authorization Failed!

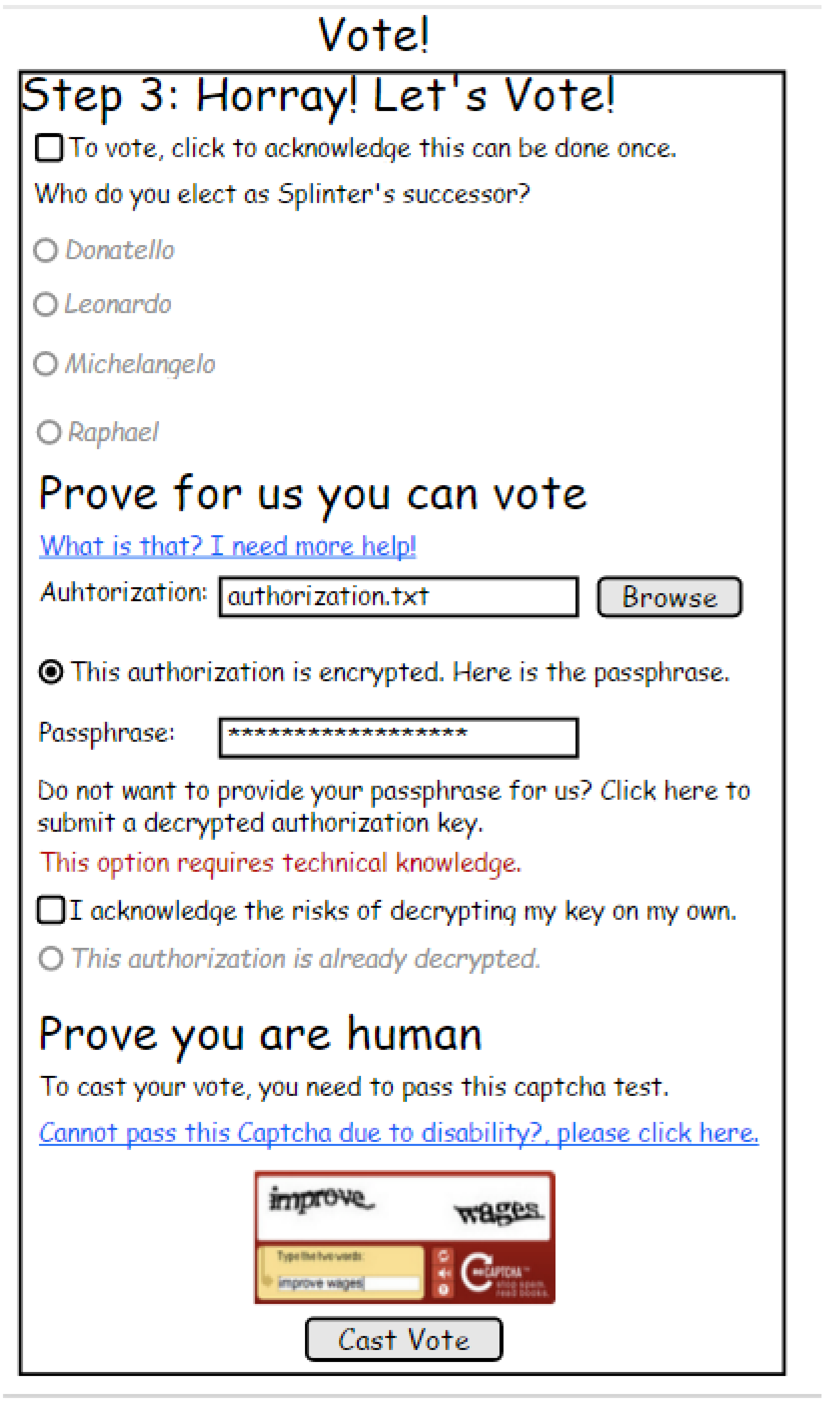
You were not authorized to vote. Your vote was not tallied. You either already voted or entered unauthorized information.

You have 4 more trials to authorize. If failed, you will be blocked from authorization.

Need help? Please contact us!

I did not issue my authorization key yet. Take me to get it.

Figure 6.6: A failed authorization attempt



Vote!

Step 3: Horray! Let's Vote!

☐ To vote, click to acknowledge this can be done once.

Who do you elect as Splinter's successor?

○ *Donatello*

○ *Leonardo*

○ *Michelangelo*

○ *Raphael*

Prove for us you can vote

What is that? I need more help!

Auhtorization: authorization.txt Browse

● This authorization is encrypted. Here is the passphrase.

Passphrase: ******************

Do not want to provide your passphrase for us? Click here to submit a decrypted authorization key.

This option requires technical knowledge.

☐ I acknowledge the risks of decrypting my key on my own.

○ *This authorization is already decrypted.*

Prove you are human

To cast your vote, you need to pass this captcha test.

Cannot pass this Captcha due to disability?, please click here.

improve wages

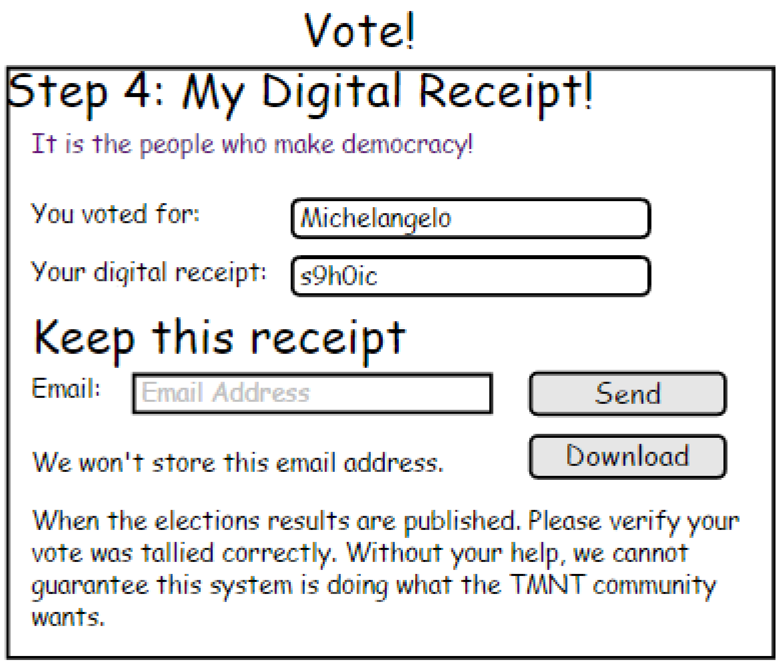
Type the two words:

improve wages

Cast Vote

Figure 6.7: The voting form where the user casts their vote

Finally, the user gets a digital receipt that he can use to check and verify that his vote was tallied correctly.



Vote!

Step 4: My Digital Receipt!

It is the people who make democracy!

You voted for:	Michelangelo
Your digital receipt:	s9h0ic

Keep this receipt

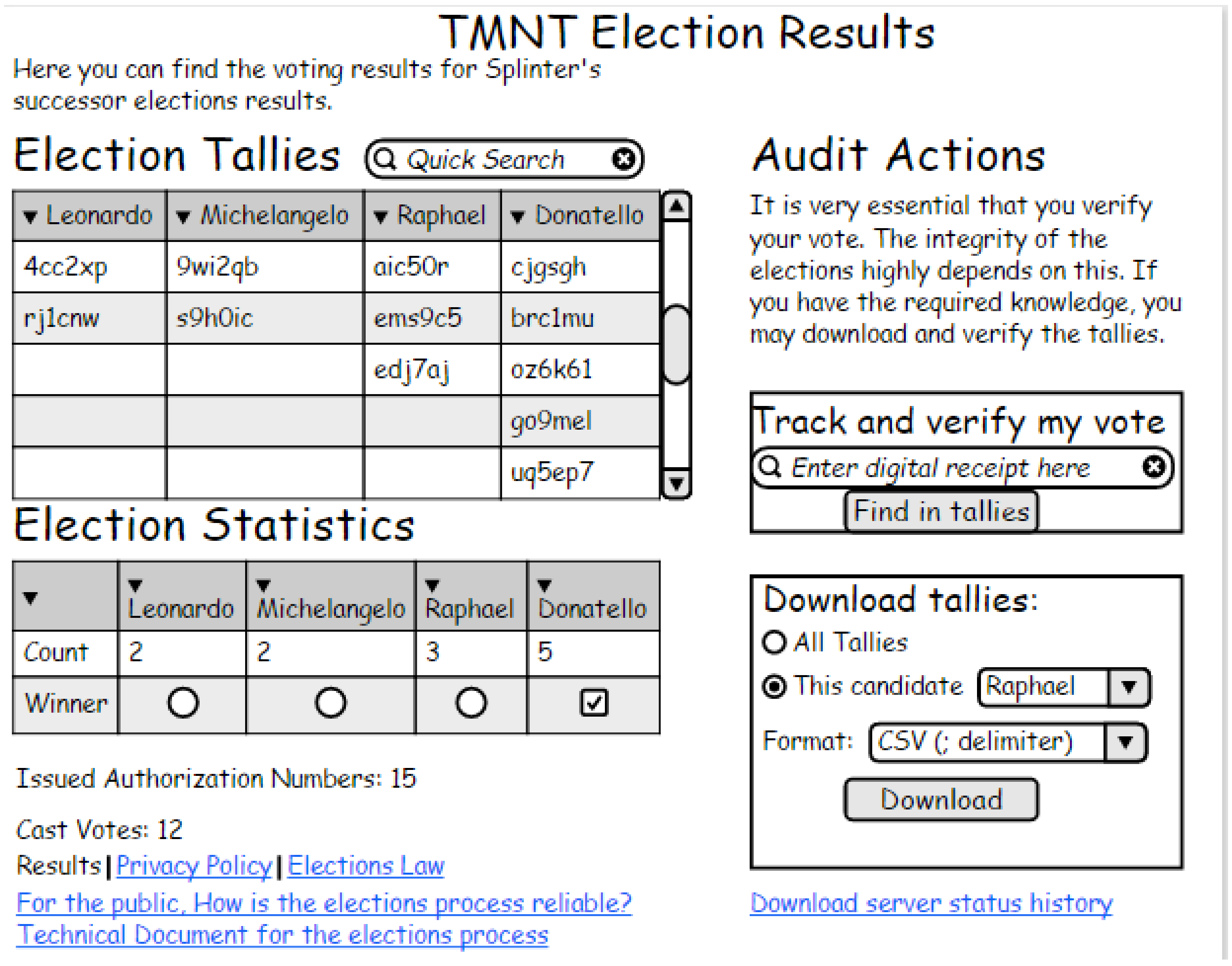
Email: Email Address

We won't store this email address.

When the elections results are published. Please verify your vote was tallied correctly. Without your help, we cannot guarantee this system is doing what the TMNT community wants.

Figure 6.8: The digital receipt that the voter receives after successful voting

Finally, the user after the election ends can view the election results and verify his vote was tallied.



TMNT Election Results

Here you can find the voting results for Splinter's successor elections results.

Election Tallies

▼ Leonardo	▼ Michelangelo	▼ Raphael	▼ Donatello
4cc2xp	9wi2qb	aic50r	cjgsgh
rj1cnw	s9h0ic	ems9c5	brc1mu
		edj7aj	oz6k61
			go9mel
			uq5ep7

Election Statistics

▼	▼ Leonardo	▼ Michelangelo	▼ Raphael	▼ Donatello
Count	2	2	3	5
Winner	○	○	○	✓

Issued Authorization Numbers: 15

Cast Votes: 12

Results | Privacy Policy | Elections Law

For the public, How is the elections process reliable?

Technical Document for the elections process

Audit Actions

It is very essential that you verify your vote. The integrity of the elections highly depends on this. If you have the required knowledge, you may download and verify the tallies.

Track and verify my vote

Download tallies:

○ All Tallies

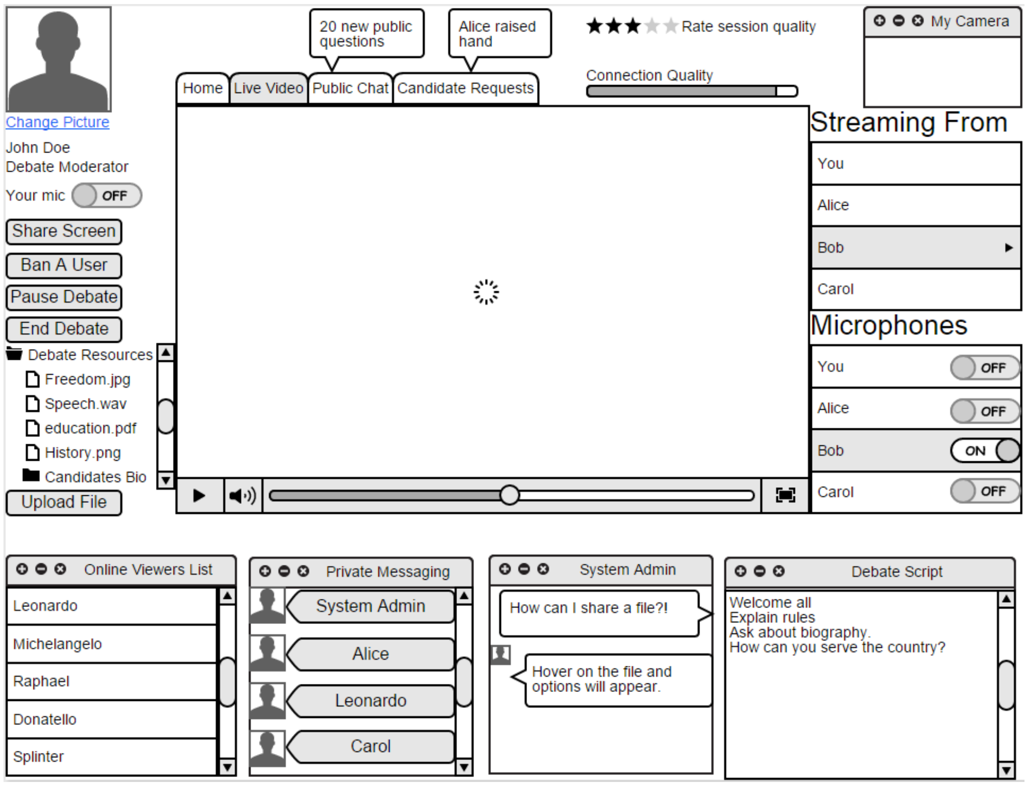
● This candidate: Raphael

Format: CSV (; delimiter)

Download server status history

Figure 6.9: The election results viewed publicly so that the voter can verify his vote

6.2.3. Debating



How can I share a file?!

Hover on the file and options will appear.

Welcome all
Explain rules
Ask about biography.
How can you serve the country?

Figure 6.10: The debating screen as seen by the moderator

6.3 Screen Objects and Actions

In this section, a description table is given for the important interface elements and controls in the figures outlined in section 6.2.

Table 6.1.: Description of the interface elements in Figure 6.1

Group of Element(s)	Type	Description/Action
National Number	Label + Textbox	The voter's national number as in legal documents and retrieved from the citizens database
Last Name	Label + Textbox	The user's last name for more verification and avoid lucky national number guesses
Date of Birth	Label + Textbox	The user's date of birth
Password	Label + Textbox	The password the user uses to login into the system. The password field is masked by asterix.
Human Verification	CAPTCHA (Label + Image + Textbix + Audio)	A CAPTCHA is used here where the user is required to enter it as seen. If the user is disabled, they can request to answer this challenge in another way such as audio.
Submit Button	Button	The trigger to send all the information provided for authentication

Table 6.2.: Description of the interface elements in Figure 6.2

Group of Element(s)	Type	Description/Action
National Number	Label + Textbox	The voter's national number as in legal documents and retrieved from the citizens database
Last Name	Label + Textbox	The user's last name for more verification and avoid lucky national number guesses
Date of Birth	Label + Textbox	The user's date of birth
Password	Label + Textbox	The password the user uses to login into the system. The password field is masked by asterix.
Human Verification	CAPTCHA (Label + Image + Textbix + Audio)	A CAPTCHA is used here where the user is required to enter it as seen. If the user is disabled, they can request to answer this challenge in another way such as audio.
Submit Button	Button	The trigger to send all the information provided for authentication
Send SMS instead	Hyperlink (or button)	Lets the user receives a message instead of a call to complete the 2nd factor authentication
Verification Code	Label + Textbox	A textbox to let the user enters the verification code received on mobile
Verify	Button	The button used to submit the verification code for checking.

Table 6.3.: Description of the interface elements in Figure 6.3

Group of Element(s)	Type	Description/Action
Navigation options	Multiple Radio buttons	Allows the voter to navigate to where he wants. The user can choose to generate an authorization key, go

		to voting or do both in sequence
Terms and Conditions	Checkbox	The user marks this to express his agreement to the terms, conditions and laws of the service.
Submit	Button	Takes the user to his determined choice

Table 6.4.: Description of the interface elements in Figure 6.4

Group of Element(s)	Type	Description/Action
Passphrase	Label + Textbox	The passphrase used to encrypt the user's authorization number.
Passphrase confirmation	Label + Textbox	The user is requested to re-enter their information for double checking.
Terms and conditions	2 checkboxes	

Table 6.6.: Description of the interface elements in Figure 6.5

Group of Element(s)	Type	Description/Action
Download Key	Button	Lets the user download the encrypted authorization key to his local machine
Re-email key	Button	Sends again the encrypted authorization key to the email address so that the user can use it later
Help	Button	Request help by navigating to FAQ or a live help agent
Proceed to Vote	Button	Takes the user to cast their vote directly

Table 6.6.: Description of the interface elements in Figure 6.6

Group of Element(s)	Type	Description/Action
Message	Paragraph	A message to the user indicating that his authorization failed
Help	Hyperlink	Request help by navigating to FAQ or a live help agent
Issue authorization key	Hyperlink	Navigates to the page where the user can issue an authorization key

Table 6.7: Description of the interface elements in Figure 6.7

Group of Element(s)	Type	Description/Action
Acknowledgment	Checkbox	To make sure the user is aware that the voting process can only be done once.
Election Question	Label + Multiple Radio buttons	To capture the voter's answer to the election question(s)
Help with authorization key	Hyperlink	Navigates to help and information about the authorization key.
Authorization	Textbox	The path to the authorization file of the user
Browse	Button	Opens a file browsing dialog to get the file
Passphrase	Textbox	Passphrase for encryption of the authorization key if it is encrypted
Decryption-By-User option	Checkbox + Radio button	Allows the user to send a decrypted authorization key
Human Verification	CAPTCHA (Label + Image + Textbix + Audio)	A CAPTCHA is used here where the user is required to enter it as seen. If the user is disabled, they can request to answer this challenge in another way such as audio.
Disability Help	Hyperlink	Help with disability issues in casting the vote

Table 6.8.: Description of the interface elements in Figure 6.8

Group of Element(s)	Type	Description/Action
Voted for	Lable + Non-editable textbox	The selection of the voters that has been tabulated
Digital Receipt	Lable + Non-editable textbox	The unique digital receipt that the user can use after the elections to verify his vote
E-mail Address	Textbox	The email address to send the digital receipt to. ***This email must not be tracked into the system***
Send	Button	Sends the digital receipt to this email address
Download	Button	Download the digital receipt