TERNA ENGINEERING COLLEGE

DEPARTMENT OF COPUTER ENGINEERING

“Online Voting System Using Blockchain”

BE/SEM-VII

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Under the guidance of

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Academic Year

2024-25

CONTENT

INTRODUCTION

This project focuses on using blockchain technology to improve the security and transparency of voting systems. Existing methods face issues like fraud and lack of trust, which blockchain's decentralized ledger can mitigate. The project builds on previous work to create a verifiable and secure voting system, advancing digital democracy.

ABSTRACT

This project develops a blockchain-based online voting system to enhance election security and transparency. By leveraging blockchain's immutable and decentralized features, the system prevents vote tampering and ensures real-time verification, addressing traditional voting challenges. The study aims to modernize and secure the electoral process through a reliable digital platform.

PROBLEM STATEMENT & OBJECTIVE

- **PROBLEM STATEMENT :**

Traditional voting methods are vulnerable to errors, tampering, even cost high, and lack transparency, leading to inefficiencies and security concerns. The growing demand for trustworthy elections highlights the need for a secure, modern solution.

- **OBJECTIVE:**

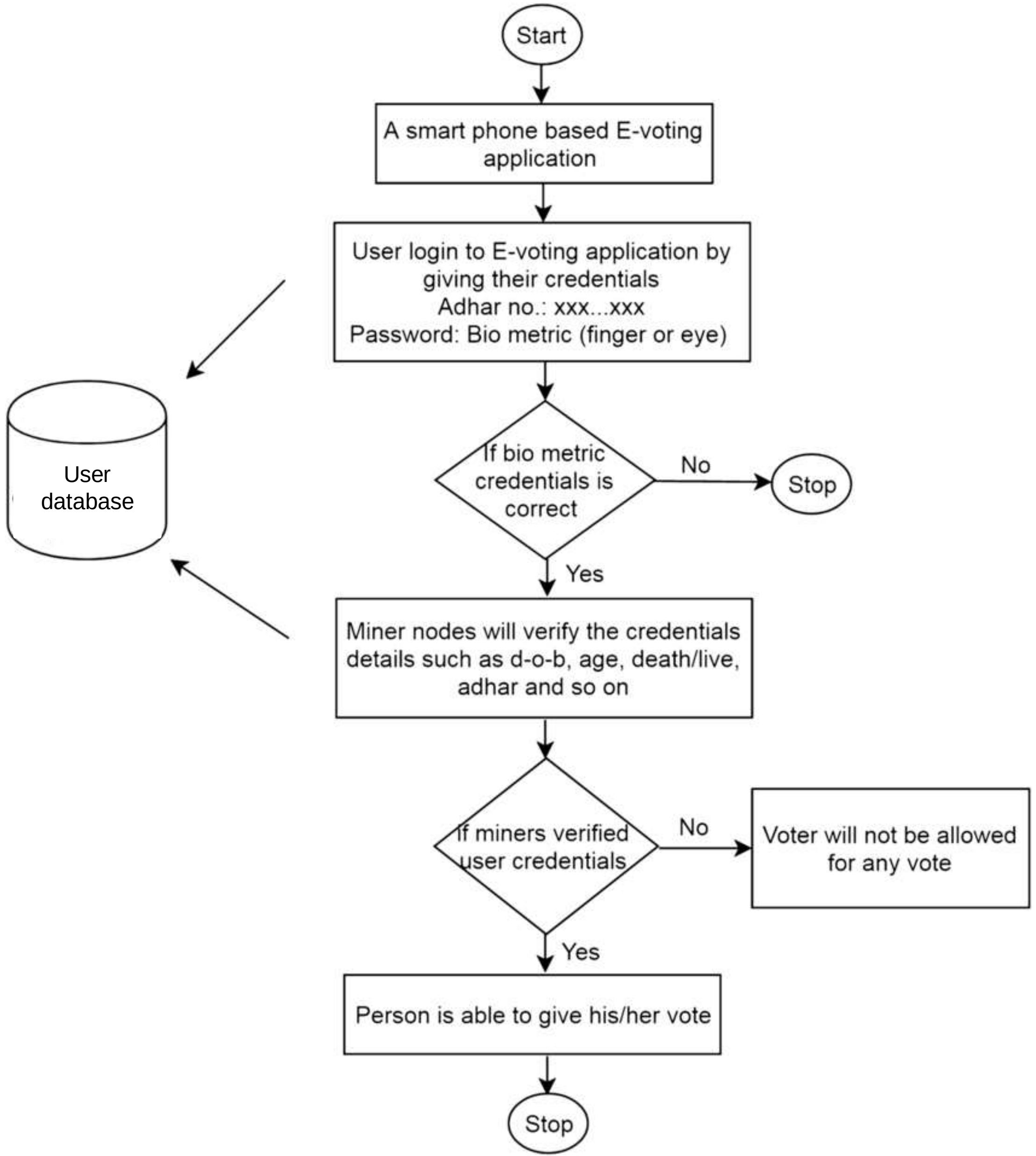
The objective is to enhance security, increase transparency, and ensure voter privacy while improving accessibility and guaranteeing immutability. Additionally, the project aims to reduce costs, enhance trust, and facilitate real-time results.

SCOPE OF THE PROJECT

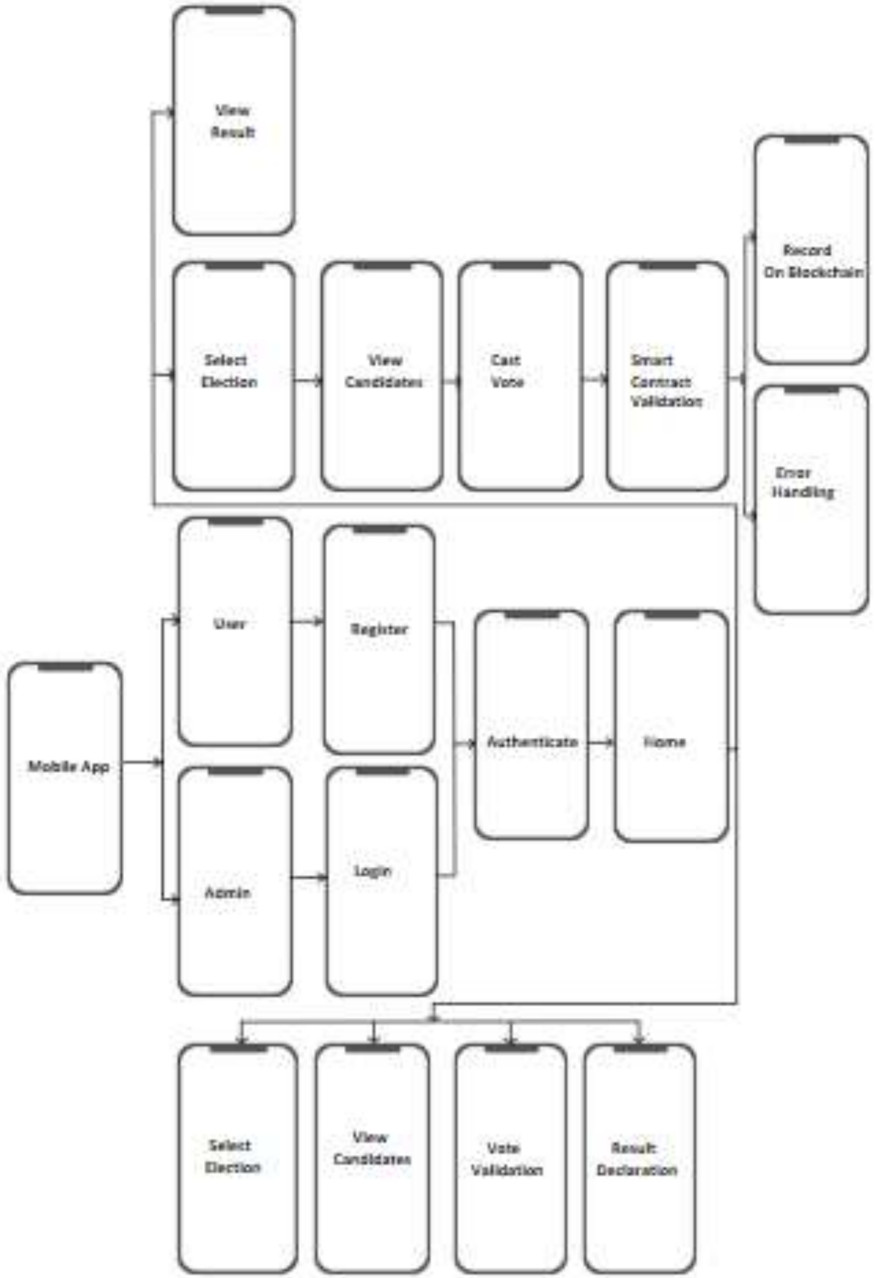
This system will replace traditional voting methods with a decentralized approach, significantly enhancing the integrity and trustworthiness of the electoral process. The scope of the project encompasses the development of a robust mobile application, seamlessly integrated with blockchain technology to ensure secure and transparent voting. Additionally, the project includes the integration of a secondary database to support data management and backup, ensuring reliability. Focus will also be placed on implementing advanced security measures and optimizing performance to safeguard the system against potential threats. Lastly, the project will address scalability to ensure the system can efficiently handle a large number of users and transactions, maintaining high performance during peak voting periods.

PROPOSED SYSTEM

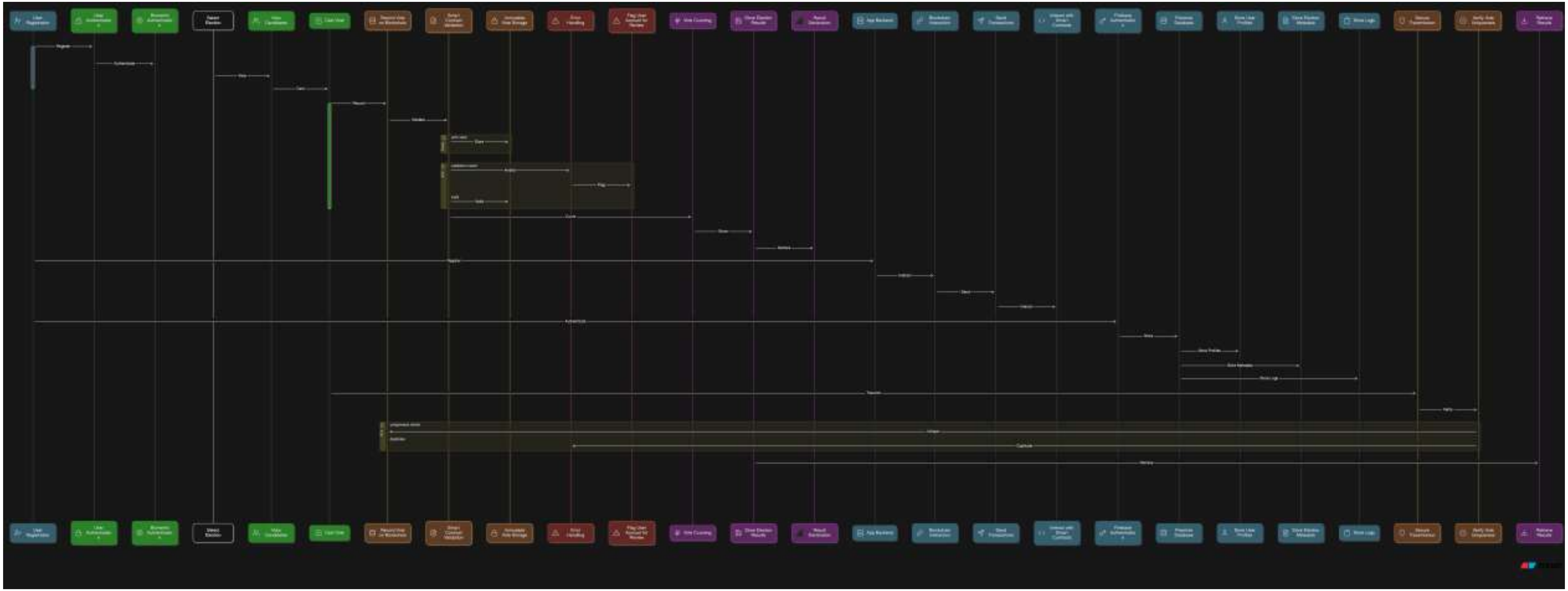
Flow Chart :



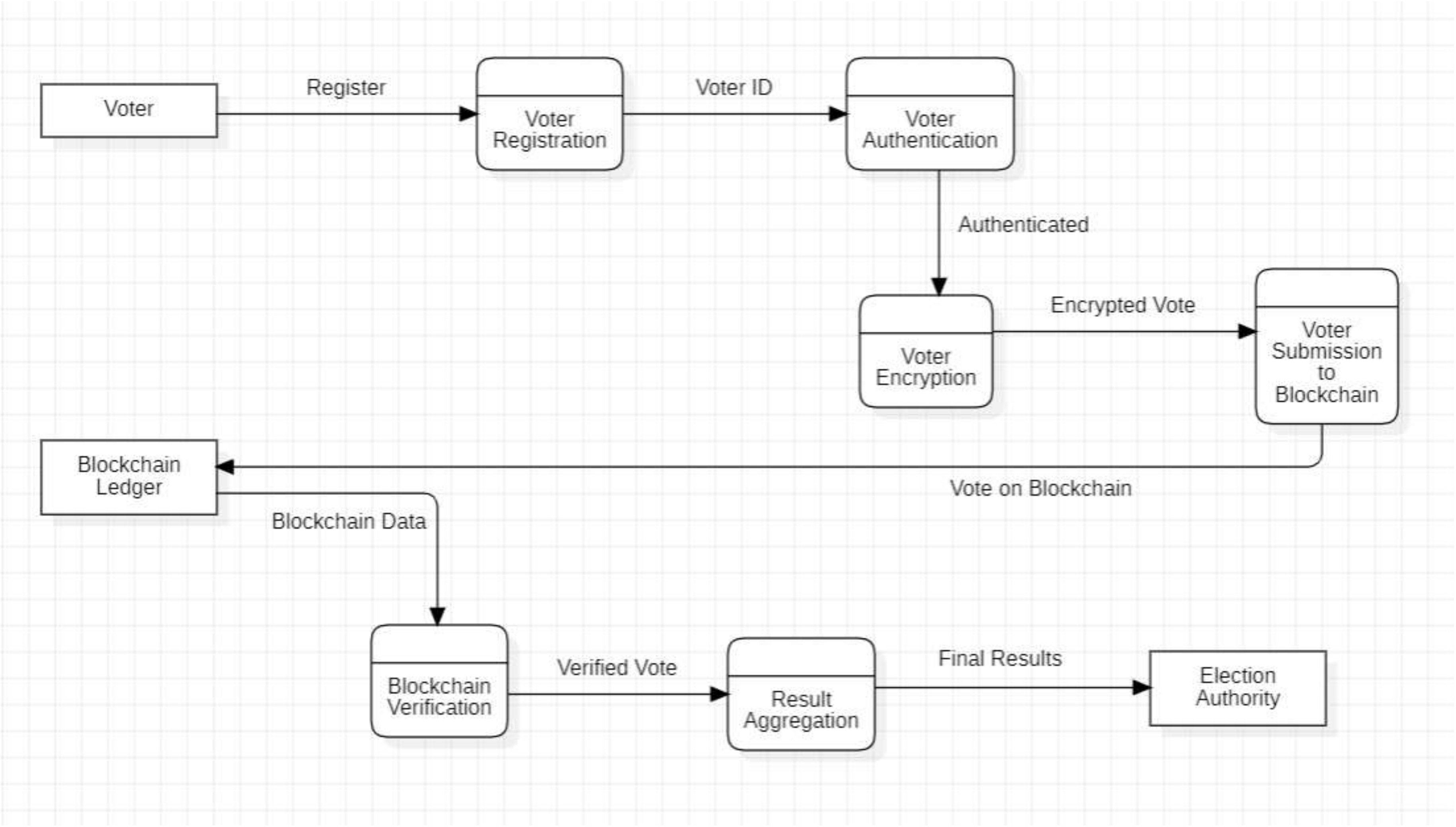
Architecture Diagram:



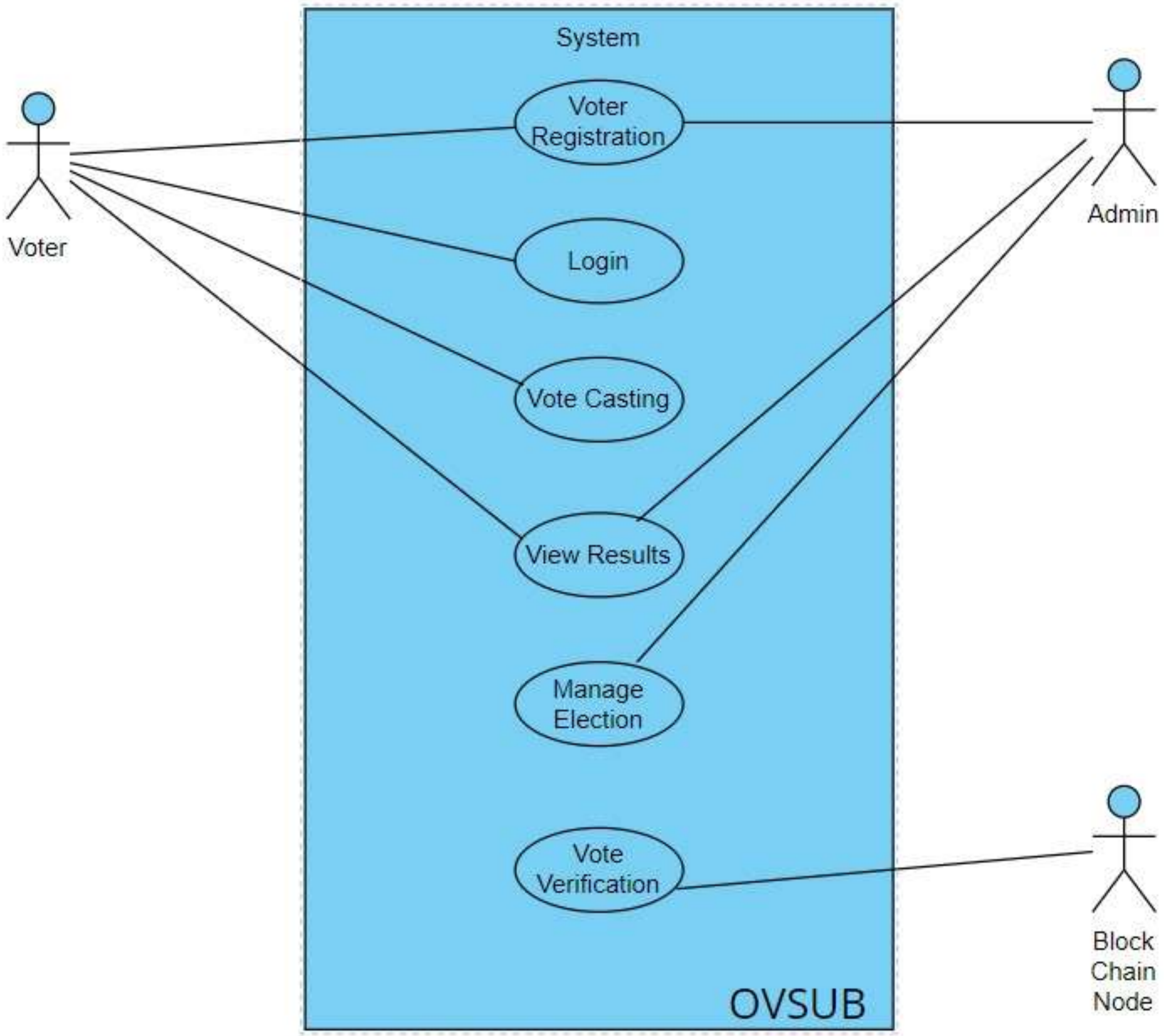
Sequence Diagram :-



Data Flow Diagram (DFD) :-



Use Case Diagram (UCD) :-



PROPOSED SYSTEM

1. Users register and log in using multi factor authentication, secured by biometric and two-factor authentication.
2. After successful login, they cast votes via a secure interface, with each vote recorded on the Ethereum blockchain using Solidity smart contracts to ensure uniqueness and prevent duplication.
3. Non-sensitive data / metadata is stored in Secondary database, while sensitive vote data is securely stored on the blockchain for transparency.
4. Real-time election results are fetched from the blockchain and displayed on a user-friendly interface developed in Android /Flutter.
5. The system ensures end-to-end encryption, voter anonymity, and is designed to handle large user loads during peak voting times.

HARDWARE USED

1. **Mobile Devices:**
   1. Smartphones (iOS and Android)
   2. Tablets (iOS and Android)
2. **Servers:**
   1. Blockchain nodes servers
   2. Backend servers
3. **Cryptographic Hardware:**
   1. Hardware Security Modules (HSM)
4. **Development and Testing Hardware:**
   1. Laptops/Desktops for developers
   2. Test devices (various models of smartphones and tablets)
5. **Security Hardware:**
   1. Biometric authentication devices (optional, for enhanced security)
   2. Two-factor authentication (2FA) devices

SOFTWARE USED

1.Blockchain Network:
- Ethereum

2. Smart Contract (Development):
- Solidity

3. Mobile App Development Frameworks:
- Android
- Flutter

4. Database:
- Firebase
- MongoDB

5. Development and Testing Tools:
- Truffle
- Ganache
- Android Studio
- Remix IDE

6. API Integration:
- Web3.js
- Ethers.js

EXPECTED OUTCOMES

We expect that the system will allow voters to securely cast their votes via a mobile application, with immutable vote records on the blockchain to prevent tampering, ensuring a transparent election process through a public ledger accessible to all, while protecting voter identity. Additionally, real-time results will be directly calculated from the system, with scalability to handle large-scale elections, and auditability will provide election officials with access to logs to maintain election integrity.

SRS Outline

1. Introduction

- **Project Overview:** The project involves developing a secure and efficient online voting system using blockchain technology.
- **Scope:** The system will allow voters to securely register, authenticate, and cast their votes. The blockchain ensures transparency and immutability in vote recording and result declaration.

2. Functional Requirements

These requirements specify what the system should do.

- **Voter Registration:**
  - Voters must register with valid identification details.
  - The system generates a unique voter ID linked to their blockchain account.
- **Voter Authentication:**
  - Implement multi-factor authentication (MFA) using passwords and one-time passwords (OTPs).
  - Ensure the system verifies voter identity before allowing access.
- **Voting Process:**
  - Voters can securely cast their votes from the web or mobile app.
  - The system should prevent double voting.
- **Blockchain Integration:**
  - Votes are recorded as immutable transactions on the blockchain.
  - Smart contracts handle vote counting and result declaration.
- **Result Declaration:**
  - Automatic real-time result processing and display after the voting ends.
  - The system should allow public verification without exposing voter identities.

3. Non-Functional Requirements

These requirements outline the system's performance, security, and usability standards.

- **Security:**
  - Implement end-to-end encryption for all data exchanges.
  - The blockchain must ensure immutability and trust in the voting data.
- **Performance:**
  - The system should handle thousands of simultaneous voters with low latency.

- Results should be processed in real-time without performance degradation.

- **Scalability:**
  - The system should support scaling to accommodate high user loads.
  - Efficient management of blockchain nodes and data processing.
- **Usability:**
  - Provide a simple and intuitive interface for voters with minimal technical skills.
  - Ensure compatibility across various devices (desktop, mobile, tablets).
- **Reliability:**
  - 99.9% uptime during voting periods.
  - Failover mechanisms in place to ensure high availability.
- **Compliance:**
  - Adhere to election laws and data privacy regulations.

4. Software Engineering Model

The **Agile Development Model** is appropriate given the iterative nature of development and the need for continuous feedback.

- **Requirement Analysis:**
  - Collaborate with stakeholders to refine requirements in iterations.
- **Design Phase:**
  - Develop architectural designs including smart contract frameworks, user interfaces, and backend infrastructure.
- **Development Phase:**
  - Implement the system in sprints, focusing on modules such as registration, voting, and result processing.
  - Integrate blockchain functionality progressively, ensuring smart contracts are robust.
- **Testing Phase:**
  - Conduct rigorous unit, integration, and user acceptance testing.
  - Test for security vulnerabilities and ensure all data remains confidential.
- **Deployment Phase:**
  - Deploy the application on cloud infrastructure.
  - Monitor performance during a simulated election and gather feedback for improvements.
- **Maintenance & Future Enhancements:**

- Post-deployment support includes fixing bugs and rolling out enhancements based on user feedback.

For use case/dfd/…

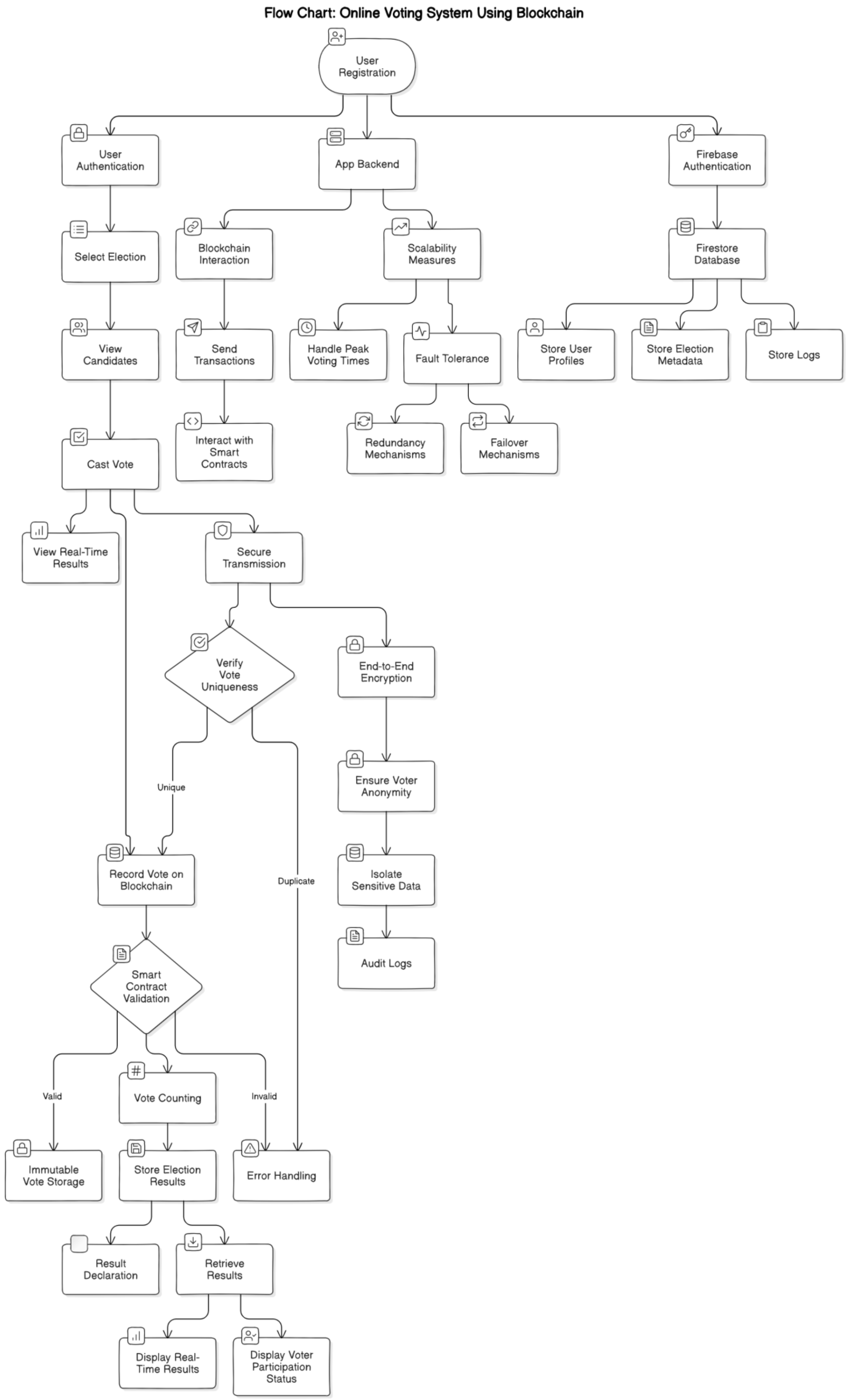
https://app.diagrams.net/

Diagram maker ai

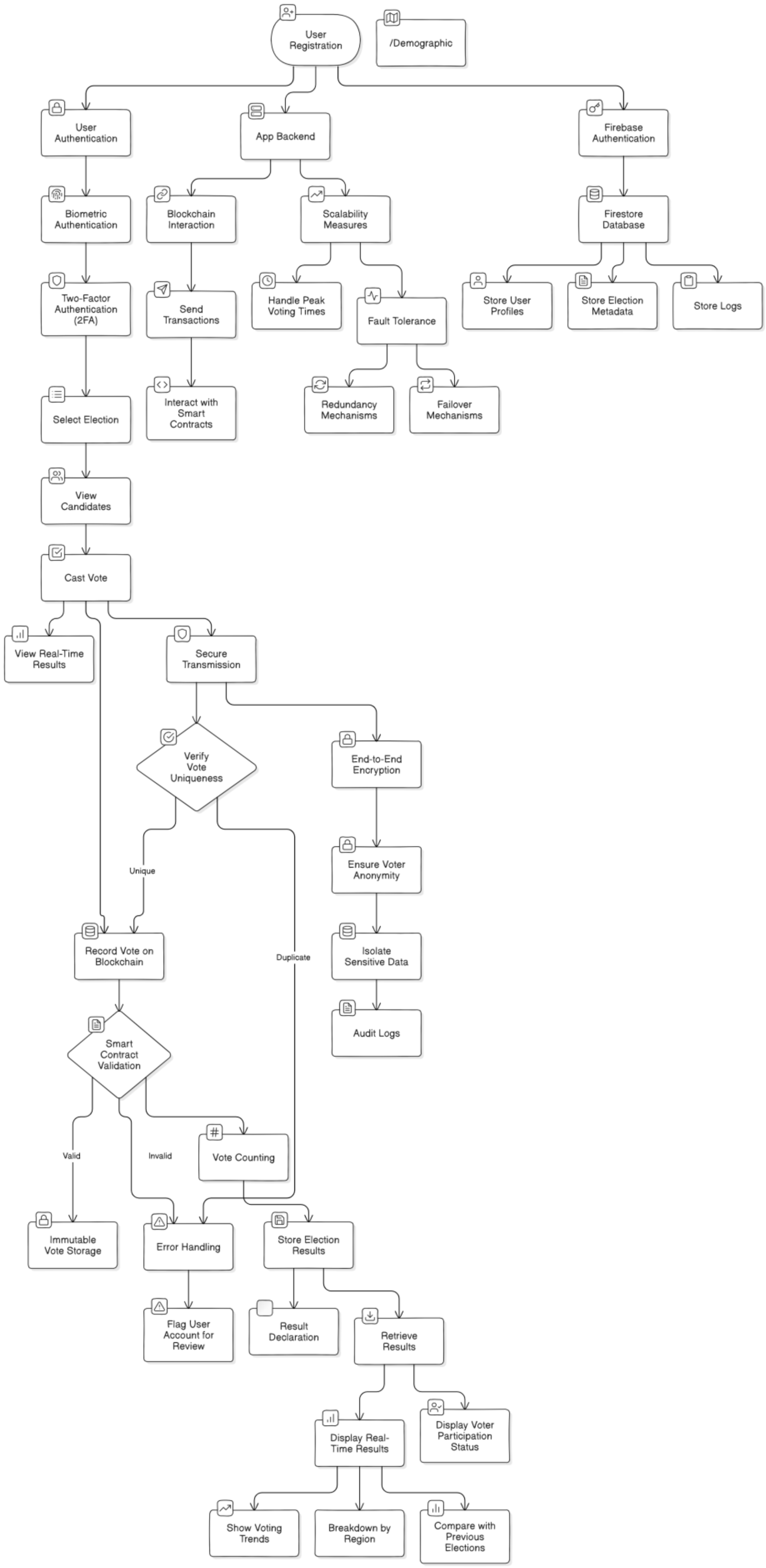
https://www.eraser.io/diagramgpt

Team invite
https://app.eraser.io/invite/y150EcRBQQl45jHYxsDg

Flow Chart

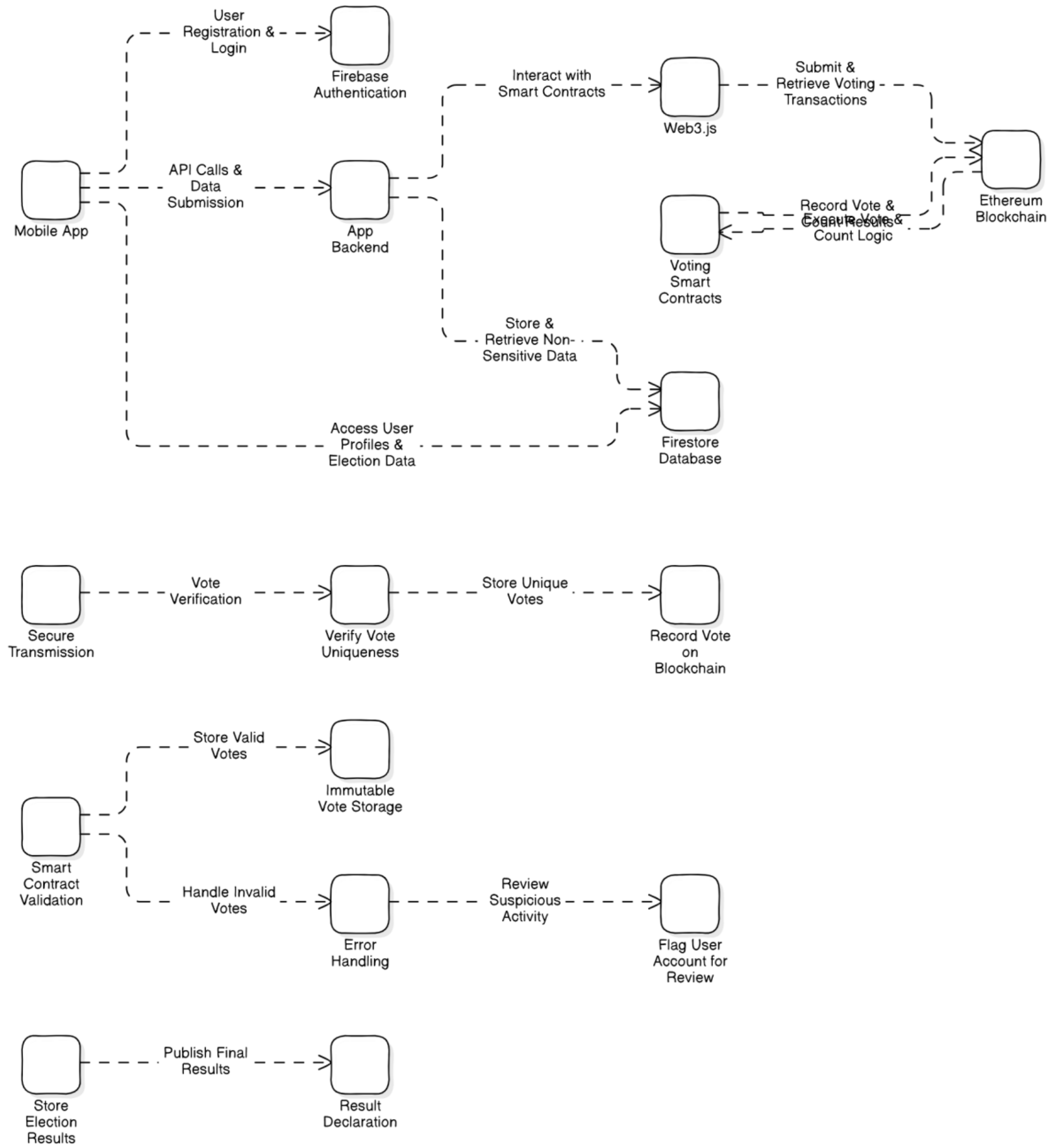

Flow Chart: Online Voting System Using Blockchain
User Registration
User Authentication
App Backend
Firebase Authentication
Select Election
Blockchain Interaction
Scalability Measures
Firestore Database
View Candidates
Send Transactions
Handle Peak Voting Times
Fault Tolerance
Store User Profiles
Store Election Metadata
Store Logs
Cast Vote
Interact with Smart Contracts
Redundancy Mechanisms
Failover Mechanisms
View Real-Time Results
Secure Transmission
Verify Vote Uniqueness
End-to-End Encryption
Unique
Ensure Voter Anonymity
Record Vote on Blockchain
Duplicate
Isolate Sensitive Data
Audit Logs
Smart Contract Validation
Valid
Vote Counting
Invalid
Immutable Vote Storage
Store Election Results
Error Handling
Result Declaration
Retrieve Results
Display Real-Time Results
Display Voter Participation Status

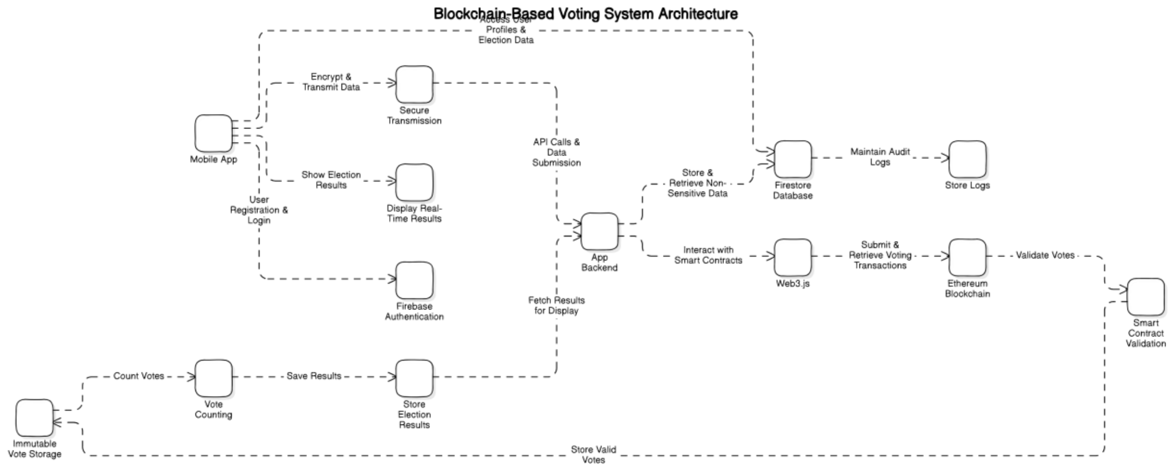
Flow Chart: Online Voting System Using Blockchain



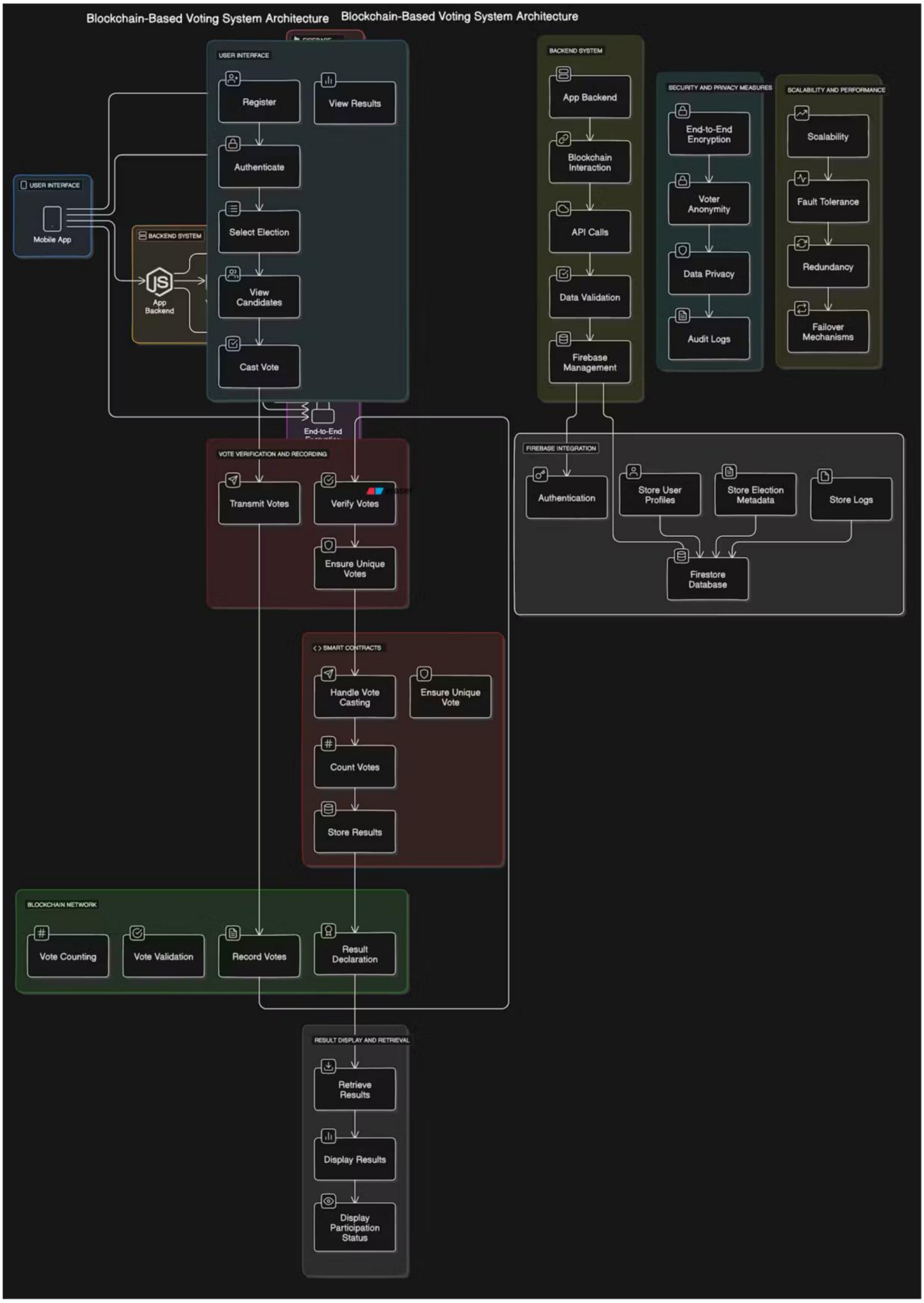
Rough Architecture

Blockchain-Based Voting System Architecture



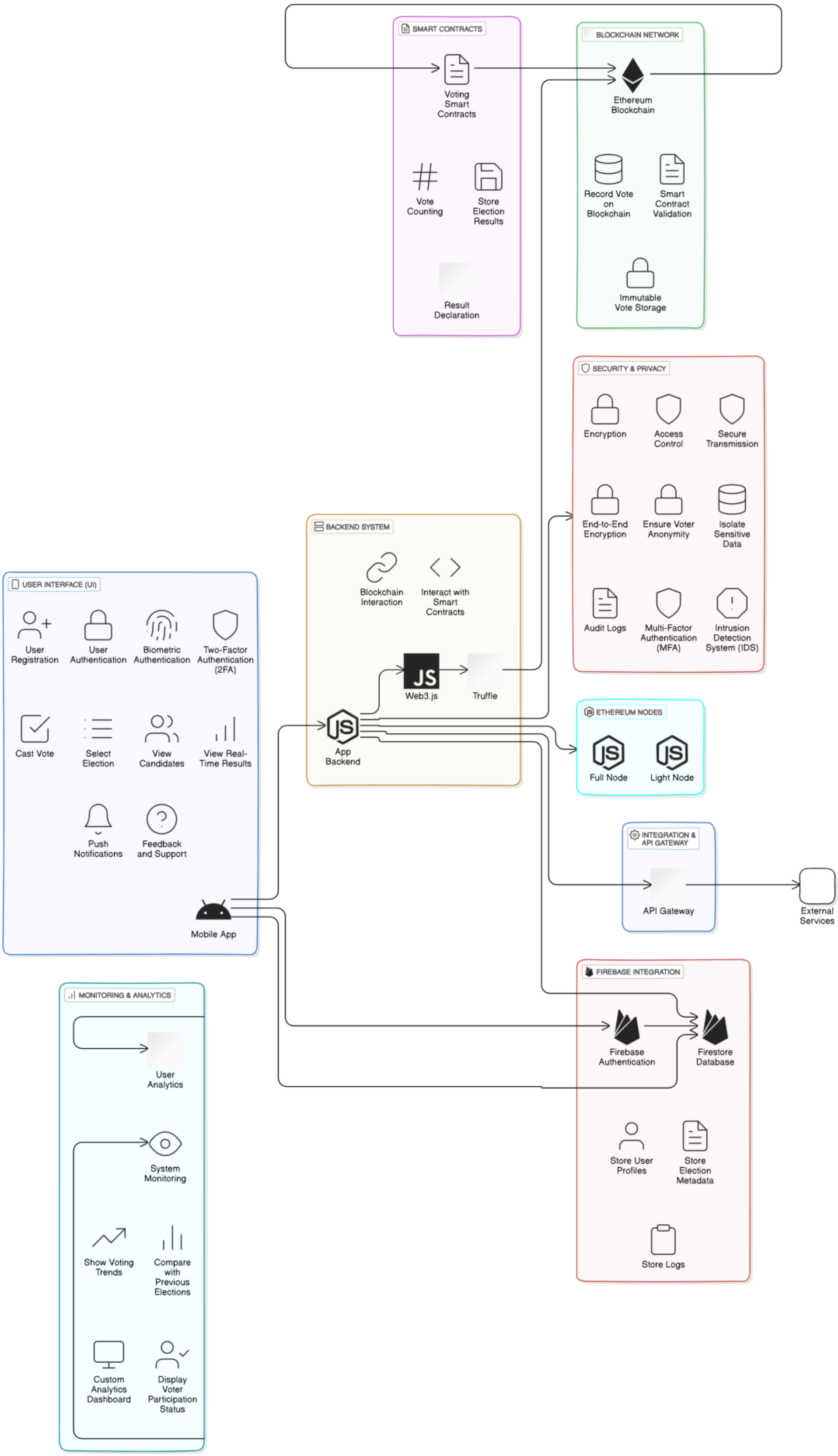

Blockchain-Based Voting System Architecture
Profiles &
Election Data
Encrypt &
Transmit Data
Secure
Transmission
Mobile App
Show Election
Results
Display Real-
Time Results
User
Registration &
Login
Firebase
Authentication
API Calls &
Data
Submission
App
Backend
Fetch Results
for Display
Store &
Retrieve Non-
Sensitive Data
Firestore
Database
Maintain Audit
Logs
Store Logs
Interact with
Smart Contracts
Web3.js
Submit &
Retrieve Voting
Transactions
Ethereum
Blockchain
Validate Votes
Smart
Contract
Validation
Count Votes
Vote
Counting
Save Results
Store
Election
Results
Immutable
Vote Storage
Store Valid
Votes

Architecture



Blockchain-Based Voting System Architecture
Blockchain-Based Voting System Architecture
USER INTERFACE
Register
View Results
Authenticate
Select Election
View Candidates
Cast Vote
USER INTERFACE
Mobile App
BACKEND SYSTEM
App Backend
End-to-End
BACKEND SYSTEM
App Backend
Blockchain Interaction
API Calls
Data Validation
Firebase Management
SECURITY AND PRIVACY MEASURES
End-to-End Encryption
Voter Anonymity
Data Privacy
Audit Logs
SCALABILITY AND PERFORMANCE
Scalability
Fault Tolerance
Redundancy
Failover Mechanisms
VOTE VERIFICATION AND RECORDING
Transmit Votes
Verify Votes
Ensure Unique Votes
FIREBASE INTEGRATION
Authentication
Store User Profiles
Store Election Metadata
Store Logs
Firestore Database
SMART CONTRACTS
Handle Vote Casting
Ensure Unique Vote
Count Votes
Store Results
BLOCKCHAIN NETWORK
Vote Counting
Vote Validation
Record Votes
Result Declaration
RESULT DISPLAY AND RETRIEVAL
Retrieve Results
Display Results
Display Participation Status

Architecture: Online Voting System Using Blockchain



Week 11 :   Analysis and Design:

Data model/data set @ page 2 & 3

https://www.scirp.org/journal/paperinformation?paperid=118849#f5

Class diagram @ page 4 , 5 & 6

https://www.freeprojectz.com/entity-relationship/voting-management-system-er-diagram

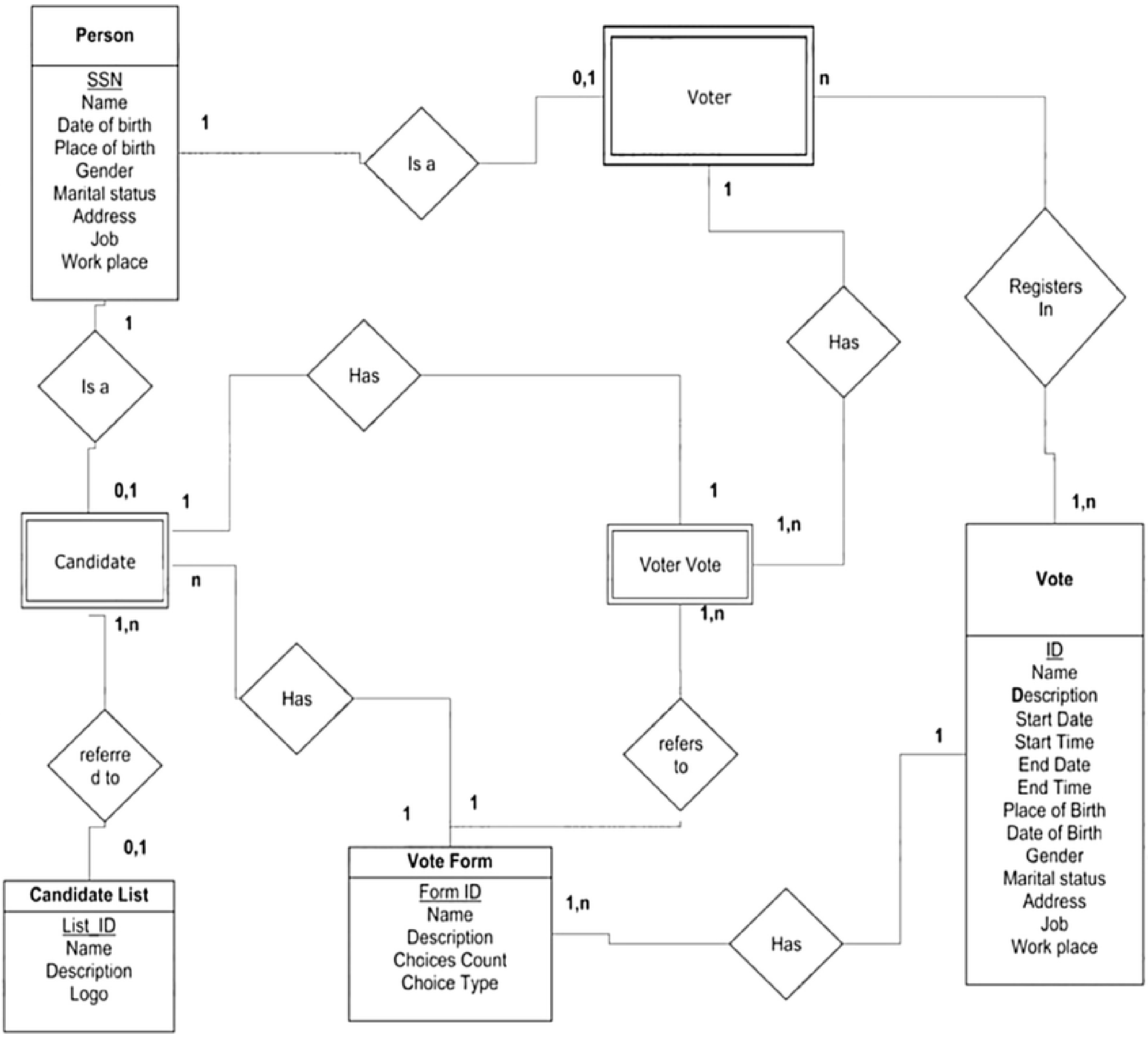
https://www.freeprojectz.com/uml-diagram/e-voting-management-system-sequence-diagram

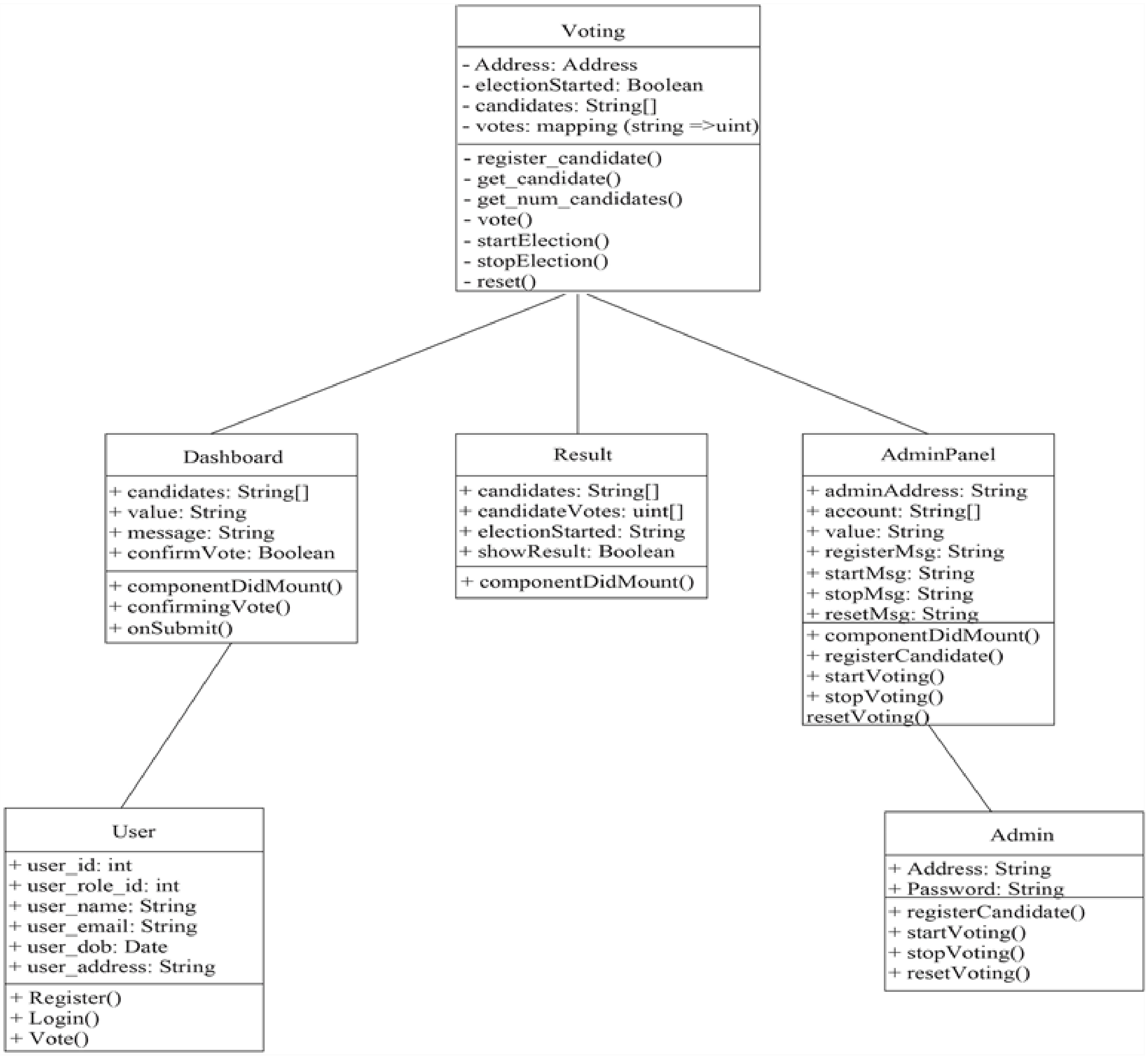
https://www.freeprojectz.com/uml-diagram/e-voting-management-system-uml-diagram

Activity diagram = Flowchart

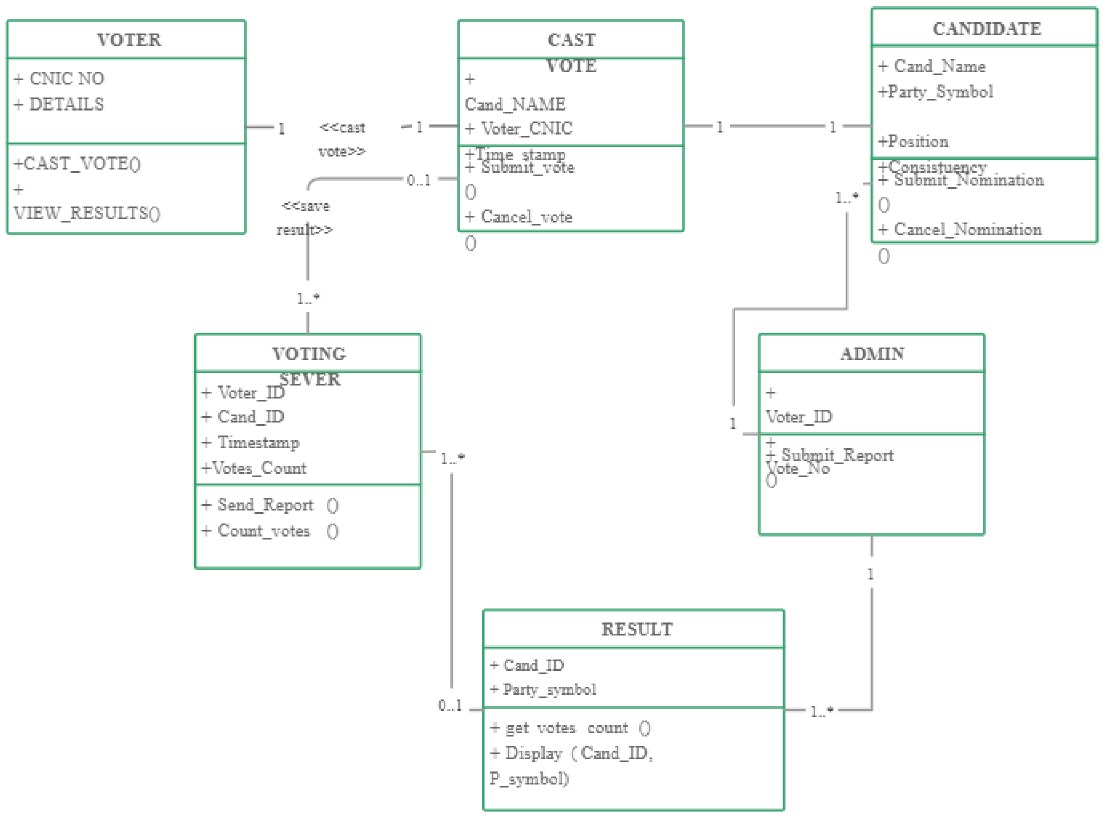
Deployment Diagram@ page 7

Data model/data set



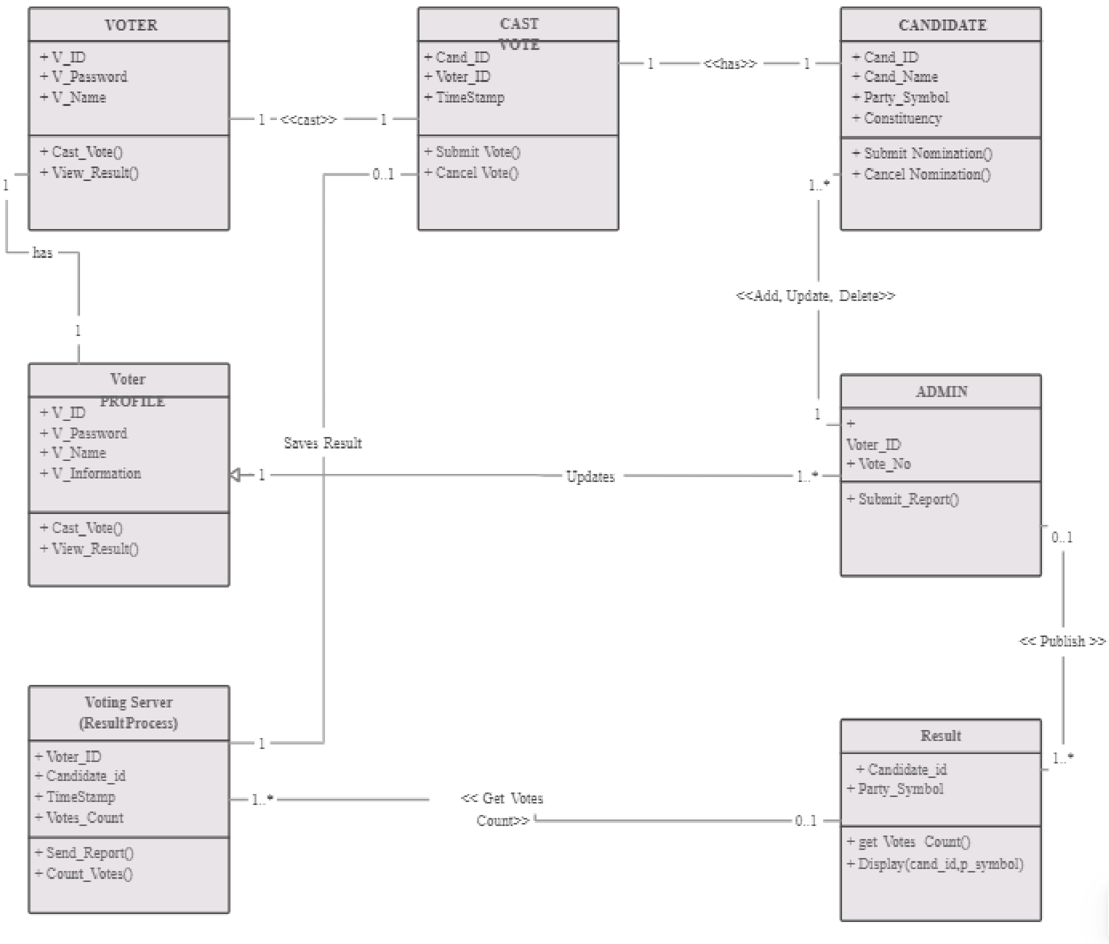

Voting
- Address: Address
- electionStarted: Boolean
- candidates: String[]
- votes: mapping (string =>uint)
- register_candidate()
- get_candidate()
- get_num_candidates()
- vote()
- startElection()
- stopElection()
- reset()
Dashboard
+ candidates: String[]
+ value: String
+ message: String
+ confirmVote: Boolean
+ componentDidMount()
+ confirmingVote()
+ onSubmit()
Result
+ candidates: String[]
+ candidateVotes: uint[]
+ electionStarted: String
+ showResult: Boolean
+ componentDidMount()
AdminPanel
+ adminAddress: String
+ account: String[]
+ value: String
+ registerMsg: String
+ startMsg: String
+ stopMsg: String
+ resetMsg: String
+ componentDidMount()
+ registerCandidate()
+ startVoting()
+ stopVoting()
resetVoting()
User
+ user_id: int
+ user_role_id: int
+ user_name: String
+ user_email: String
+ user_dob: Date
+ user_address: String
+ Register()
+ Login()
+ Vote()
Admin
+ Address: String
+ Password: String
+ registerCandidate()
+ startVoting()
+ stopVoting()
+ resetVoting()

Class diagram



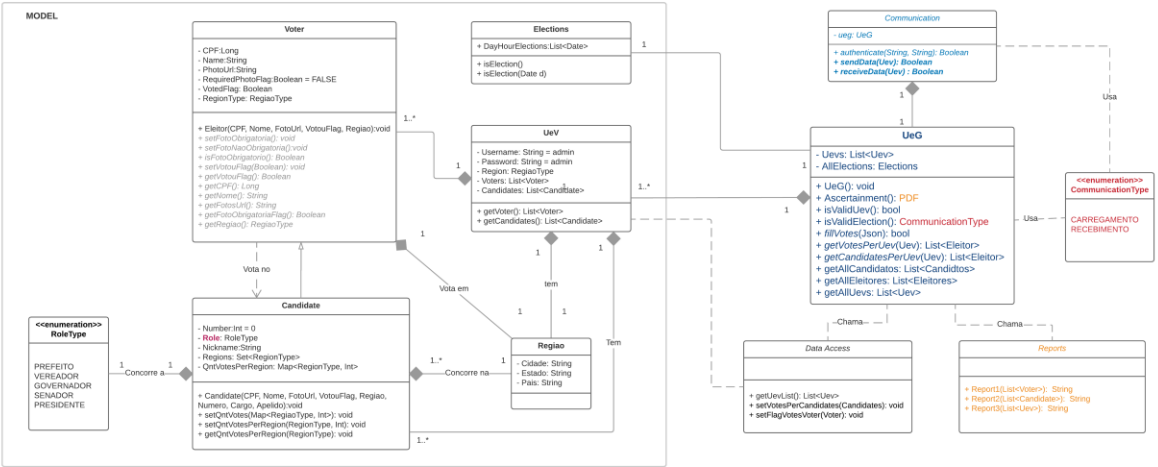
CLASS-DIAGRAMFOR ONLINE VOTING SYSTEM

E-Voting System
Class Diagram

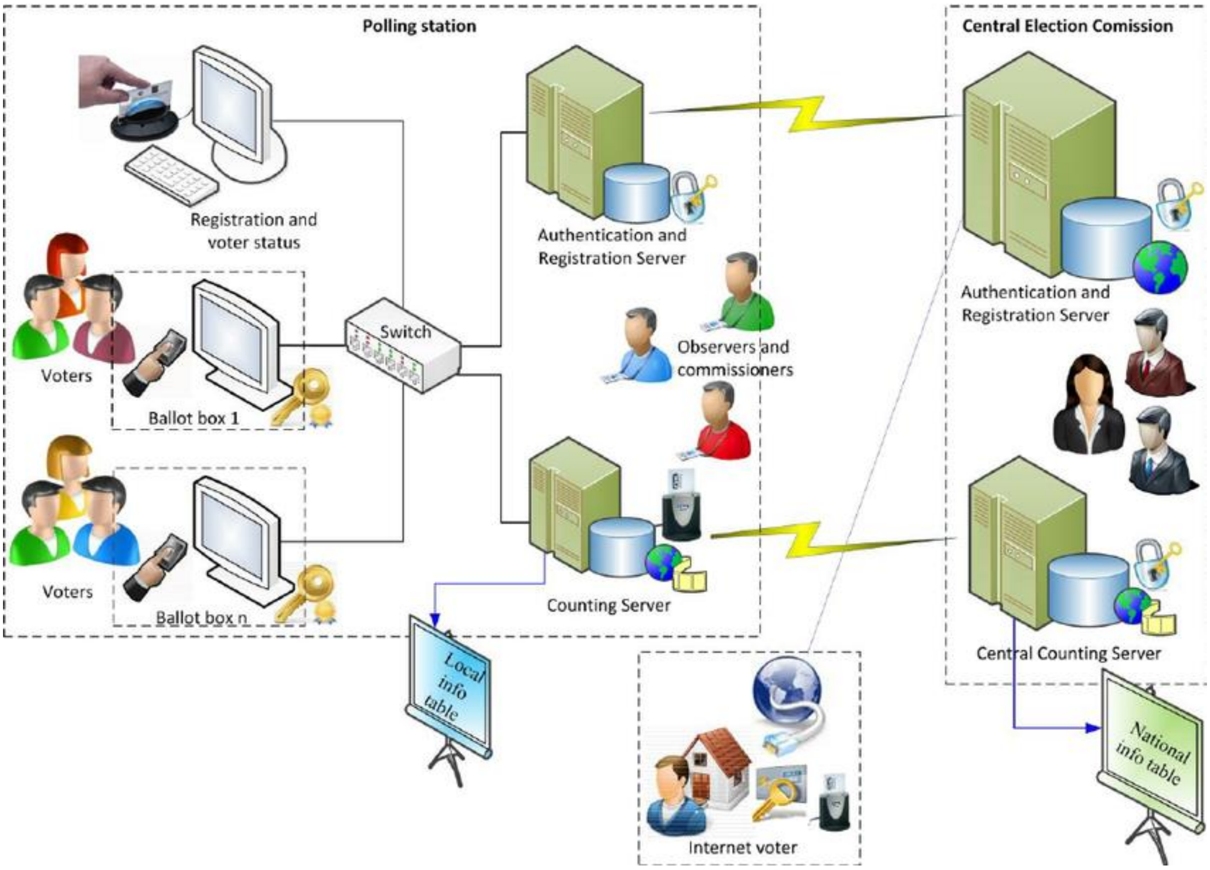


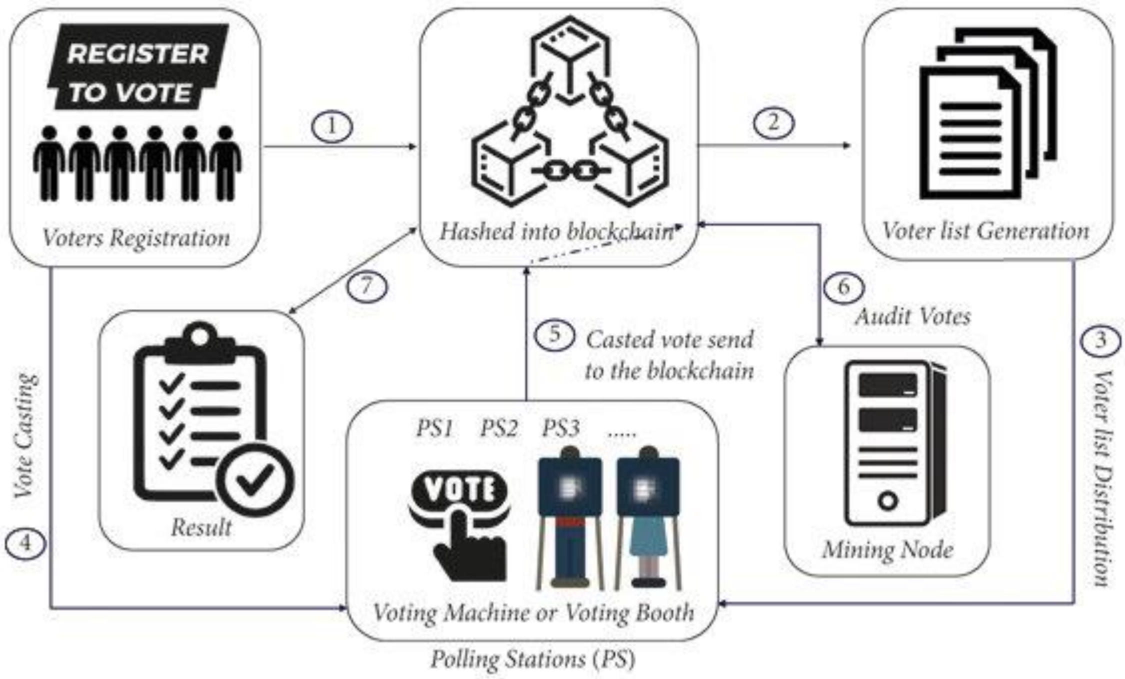
UEG - DIAGRAMA DE CLASSE

Pamela Iupi Peixinho | Ahmad Ali el Khatib



Deployment Diagram





Week 12 :

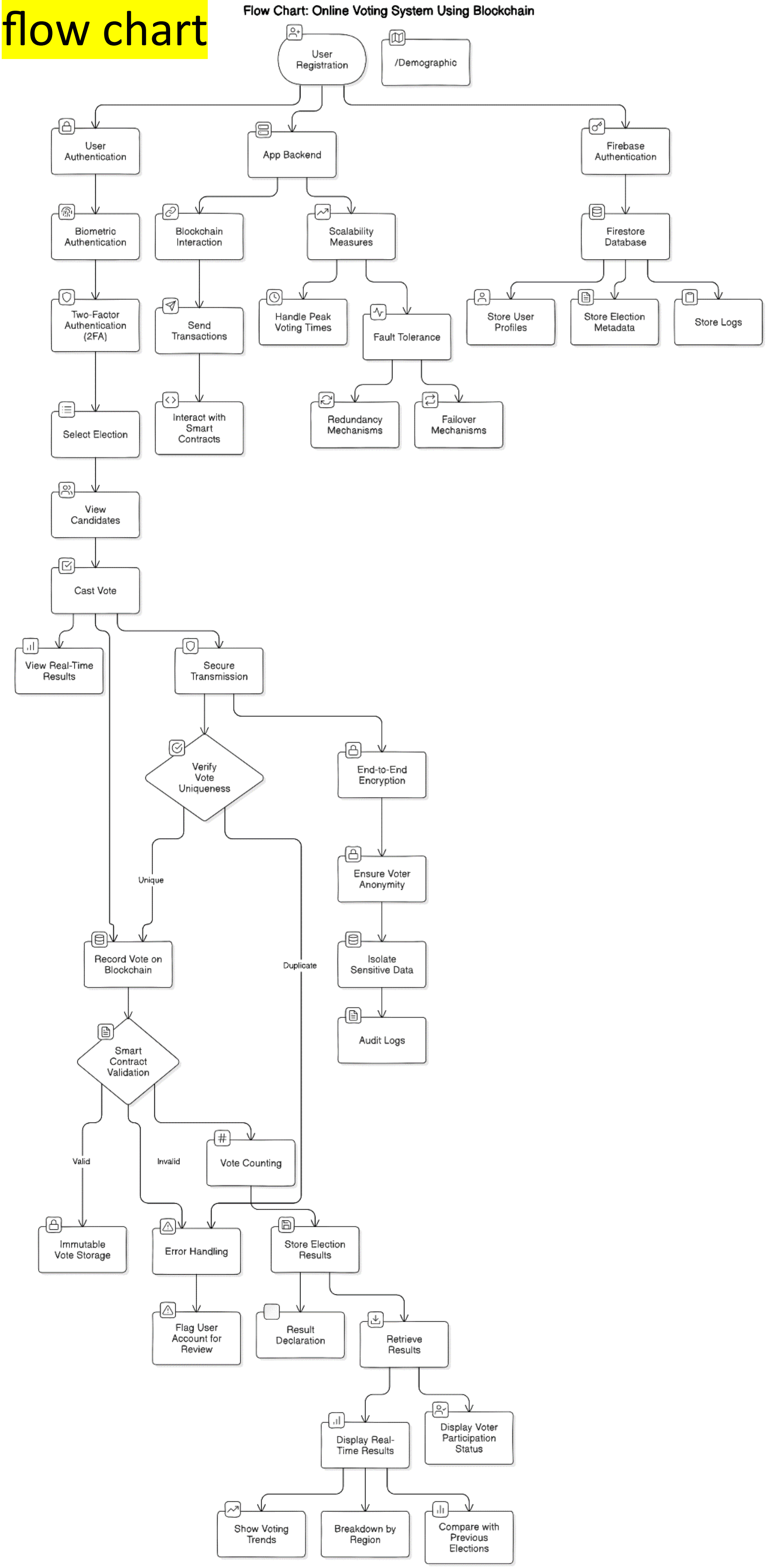
Wireframe/Algorithm

→ UI not ready

→ Algorithm == Flowchart

flow chart/Input form design/Output Report Design@ page 9 & 10

flow chart



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/Demographic
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App Backend
Firebase Authentication
Biometric Authentication
Blockchain Interaction
Scalability Measures
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Two-Factor Authentication (2FA)
Send Transactions
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Fault Tolerance
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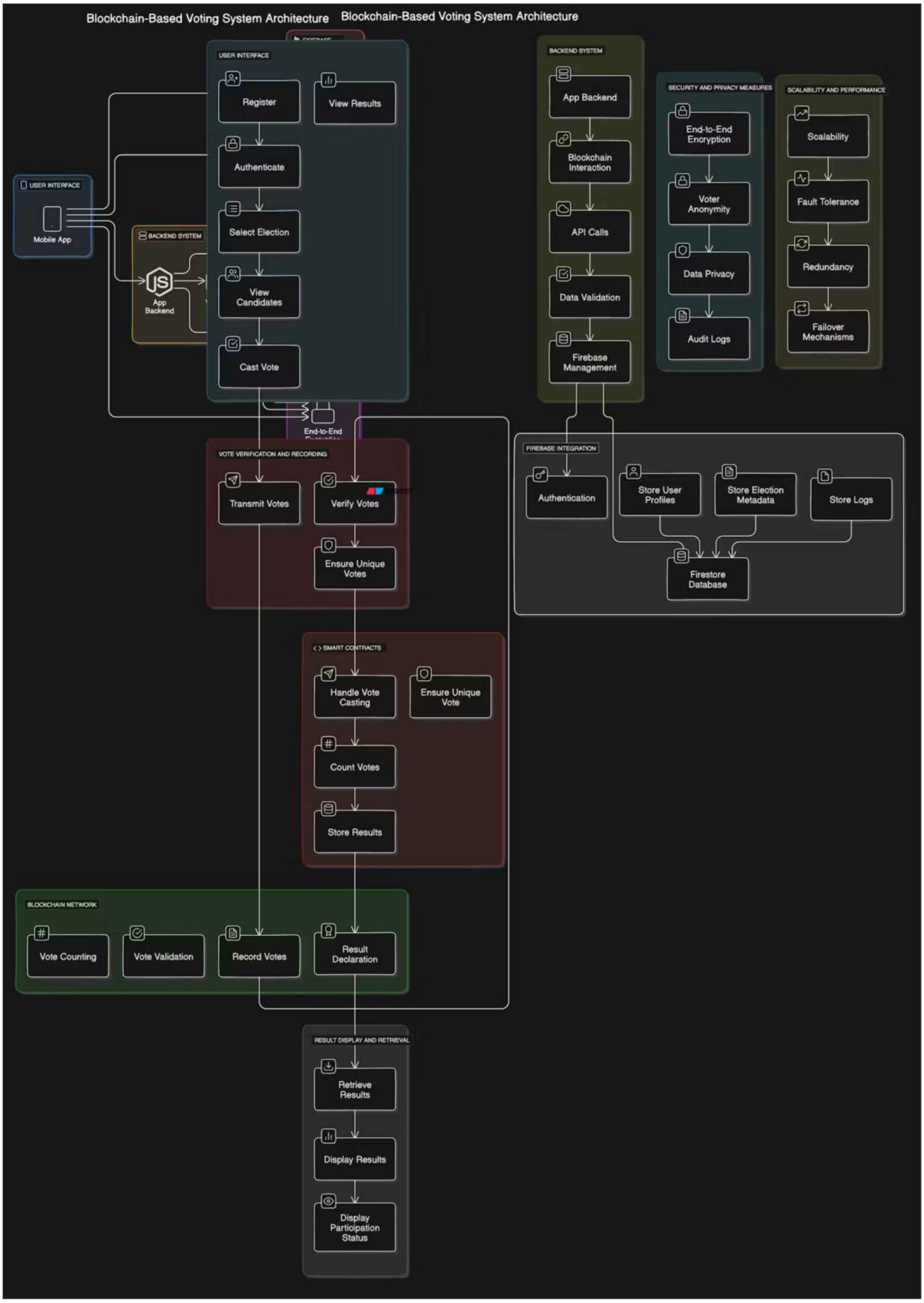
Invalid
Vote Counting
Immutable Vote Storage
Error Handling
Store Election Results
Flag User Account for Review
Result Declaration
Retrieve Results
Display Real-Time Results
Display Voter Participation Status
Show Voting Trends
Breakdown by Region
Compare with Previous Elections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USER INTERFACE
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Audit Logs
SCALABILITY AND PERFORMANCE
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Fault Tolerance
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Failover Mechanisms
VOTE VERIFICATION AND RECORDING
Transmit Votes
Verify Votes
Ensure Unique Votes
FIREBASE INTEGRATION
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Vote Counting
Vote Validation
Record Votes
Result Declaration
RESULT DISPLAY AND RETRIEVAL
Retrieve Results
Display Results
Display Participation Status

Week 13:

RMMM Plan @ page 12 & 13

Feasibility analysis @ page 14

Test case Dsign @ page 15

RMMM Plan

RMMM Plan (Risk Mitigation, Monitoring, and Management)

Table: Risk Categories

Risk ID	**Risk Category**	**Probability**	**Impact**	**Description**	**Mitigation Plan**	**Monitoring Strategy**	**Management Strategy**
RMMM 1	**Scalability**	60%	High	Ethereum's transaction throughput may cause delays, especially in large elections.	Implement transaction batching and use a private blockchain for low-cost, high-speed transactions.	Monitor transaction processing times and user load during peak voting periods.	Scale the infrastructure dynamically during high traffic voting periods.
RMMM 2	**Security**	50%	High	DDoS attacks could affect the backend or blockchain interaction, causing system downtime.	Strengthen backend security with rate limiting, firewalls, and distributed denial-of-service (DDoS) prevention mechanisms.	Continuous monitoring for unusual traffic patterns.	Activate fallback systems and reroute traffic to unaffected nodes.
RMMM 3	**Privacy**	30%	High	Sensitive voter data may be exposed due to insufficient encryption or data management practices.	Implement end-to-end encryption for all sensitive data transfers and storage.	Regular audits of encryption protocols and data flow paths.	Ensure legal compliance with privacy regulations; isolate sensitive data in blockchain.

Risk ID	Risk Category	Probability	Impact	Description	Mitigation Plan	Monitoring Strategy	Management Strategy
RMMM 4	**System Downtime**	20%	Moderate	Unexpected system downtime may cause disruption in elections.	Deploy backup servers and failover systems to ensure high availability.	Track system performance, uptime, and downtime metrics.	Have emergency support available for immediate issue resolution.
RMMM 5	**Integration Failures**	40%	Moderate	Integration between the mobile app, backend, and blockchain may face challenges.	Implement continuous integration testing for app-backend-blockchain workflows.	Monitor API responses, transaction failures, and timeout issues.	Develop fallback logic to handle temporary disconnections gracefully.

Feasibility analysis

Feasibility Analysis

Technical Feasibility

- **Blockchain for Vote Storage**: Ethereum or a similar blockchain network ensures secure, immutable, and tamper-proof vote storage. Smart contracts enable vote counting and ensure that no duplicate voting occurs.
- **Firebase for Metadata**: Storing non-sensitive data such as voter logs and metadata in Firebase provides a cost-effective and efficient solution for off-chain operations, reducing blockchain transaction costs.
- **User-Friendly Authentication**: Multi-factor authentication (MFA) with biometric verification provides a secure and easy way for voters to register and authenticate.

Financial Feasibility

- **Cost of Blockchain Transactions**: Public blockchains like Ethereum have transaction costs, but this can be minimized by using Layer 2 scaling solutions or consortium blockchains. Additionally, operations such as vote recording are optimized to avoid unnecessary costs.
- **Firebase Usage Costs**: Firebase is utilized for handling non-voting-related metadata and logs, which reduces the need for on-chain storage, keeping costs low.

Operational Feasibility

- **Ease of Use**: The mobile app is designed for ease of use, with a straightforward interface for voters to register, select elections, and cast votes. Multi-factor authentication ensures that even non-technical users can participate securely.
- **Handling Peak Voting Periods**: The system is scalable to handle a large number of users during peak voting times, ensuring that even national elections can be conducted smoothly.

Test case Dsign

Test Case Design

1. Authentication Test

- **Description**: Verify that the user authentication system works correctly with multi-factor authentication (password, biometric, OTP).
- **Input**: Voter enters email/password, biometric data, and receives OTP.
- **Expected Output**: Successful login, access granted to the dashboard.

2. Vote Casting Test

- **Description**: Ensure that votes are securely cast and recorded on the blockchain.
- **Input**: User selects election and candidate, confirms vote.
- **Expected Output**: Vote is recorded on the blockchain, transaction hash is returned, and confirmation message is displayed to the user.

3. Duplicate Voting Prevention

- **Description**: Ensure that users cannot vote more than once in the same election.
- **Input**: User attempts to cast a vote for the second time in the same election.
- **Expected Output**: Error message indicating that the user has already voted, and no new transaction is created on the blockchain.

4. Result Display Test

- **Description**: Validate that real-time results are fetched from the blockchain and displayed correctly.
- **Input**: User queries election results after voting ends.
- **Expected Output**: Real-time results fetched and displayed from the blockchain, showing vote counts by candidate and overall turnout.

5. Data Encryption and Security Test

- **Description**: Verify that all sensitive data, including votes and user details, are encrypted during transmission and storage.
- **Input**: Vote data submitted by the user.
- **Expected Output**: Data is encrypted during transmission, verified by checking the blockchain records and ensuring sensitive information remains confidential.

6. Scalability Test

- **Description**: Assess the system's ability to handle a high number of concurrent users.
- **Input**: Simulate thousands of users casting votes simultaneously.
- **Expected Output**: The system should process all votes with minimal latency and no downtime, showing no degradation in performance.

7. Failover and Recovery Test

- **Description**: Ensure that the system can recover from failures such as server crashes or blockchain node disconnection.
- **Input**: Simulate a backend server crash during voting.
- **Expected Output**: The system automatically switches to a backup server with no data loss or impact on ongoing voting processes.