VOIS Innovation Marathon 2.0

EkMat: Secure & Private Blockchain Voting

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Team No. 34

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Problem Statement

- **Eroded Trust:** Systemic irregularities and opaque data disclosure undermine public confidence in traditional voting.
- **High Operational Costs:** Managing elections involves immense manpower (1+ crore staff) and financial expenditure (over ₹4,000 crore).
- **Low Youth Participation:** Less than 40% of eligible 18–19 year-olds register to vote due to complex processes and accessibility issues.

Broken Trust & Inefficiency

Lack of transparency, high costs and low youth participation plague India's elections.

Decentralised Solution

EkMat combines blockchain, zero- knowledge proofs and IPFS with an AI assistant to deliver secure, anonymous and accessible voting.

Transformational Impact

By digitising the process, we can cut costs by ~50% and raise participation by up to 3×.

Need of Project

- **The Solution:** A decentralized "Zero-Knowledge" voting ecosystem called EkMat.
- **Restoring Confidence:** Replaces centralized trust with cryptographic verifiability, ensuring results are tamper-proof and immutable.
- **Resource Efficiency:** Automates eligibility and counting to reduce manpower by 70% and operational costs by up to 60%.
- **Inclusivity:** Empowers citizens with a digital-first approach, removing physical barriers to boost participation by up to 3x.

Proposed Solution

- **Core Concept:** A "Zero-Knowledge" Blockchain Voting system designed to redefine democratic processes by providing absolute privacy and tamper-proof security.
- **Privacy-First Architecture:** Utilizes Groth16 zk-SNARKs to prove a voter is eligible without ever revealing their identity or who they voted for.
- **Trust Through Transparency:** Replaces a centralized "black box" system with an on-chain ledger where every step is publicly auditable and verifiable.
- **Integrity Measures:** Incorporates nullifier hashing and Merkle tree eligibility checks to cryptographically ensure that double voting is impossible.
- **Cost & Labor Efficiency:** Designed to automate the verification and counting process, aiming to reduce election costs by 60% and manpower requirements by 70%.

Solution Overview

- **Decentralized Infrastructure:** Built on the Ethereum blockchain (Sepolia Testnet) to ensure that election logic and results are permanent and immutable.

- **The Voting Flow:**
  Registration: Voters are verified against an eligibility database.
  Proof Generation: SnarkJS allows voters to generate cryptographic proofs directly on their own device, keeping sensitive data private.
  On-Chain Validation: The smart contract (Verifier.sol) checks the proof and records the vote only if it passes all cryptographic hurdles.
  Censorship-Resistant Storage: Uses IPFS and Pinata to store election manifests and metadata, ensuring that no single authority can delete or alter data.

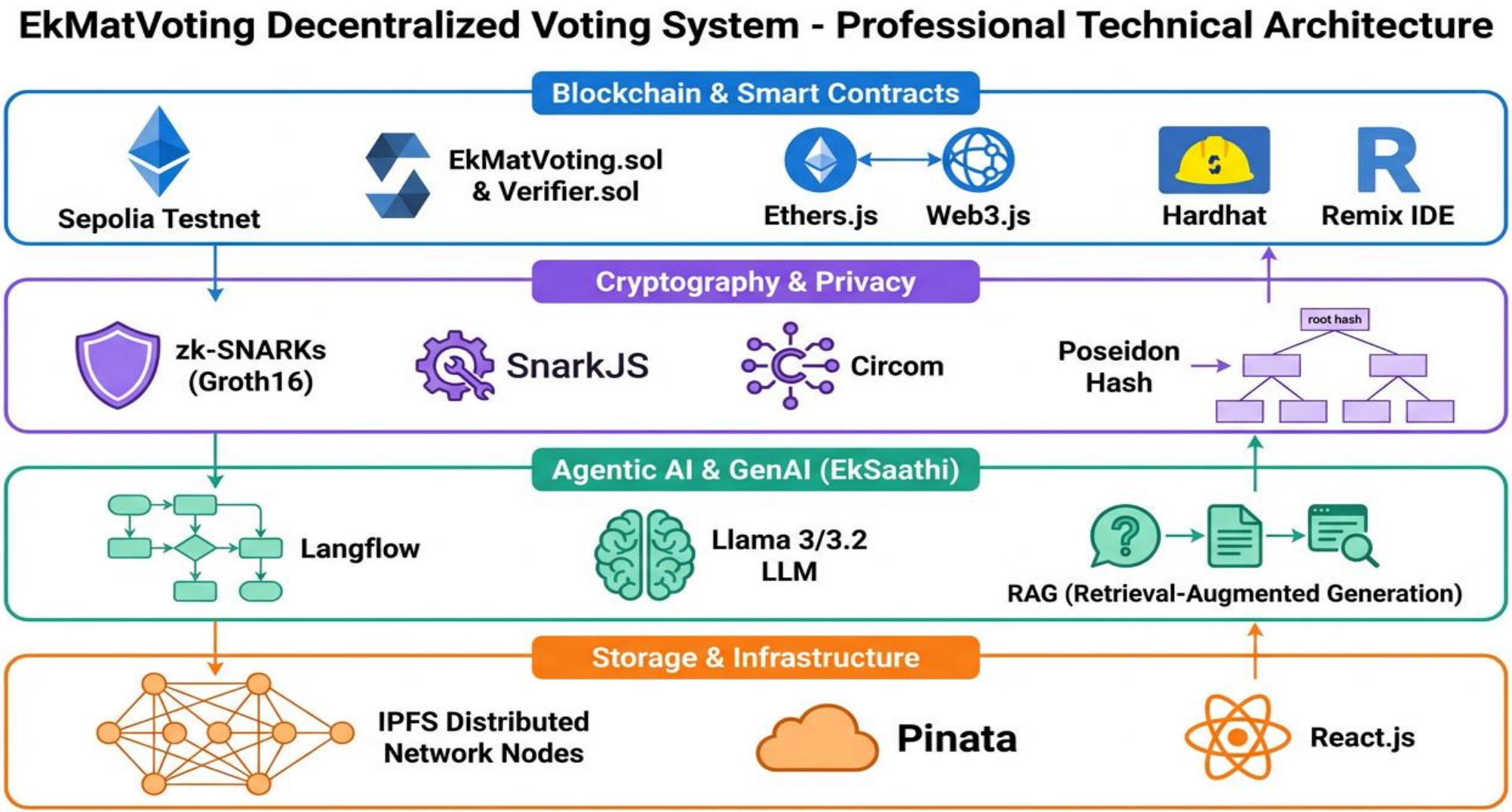
- **EkSaathi AI Assistant:** A multilingual GenAI guide (powered by Llama 3) that helps voters navigate the portal in their native language to reduce participation barriers.

- **Live Auditability:** Includes a dedicated Results Dashboard for transparent, real-time tracking of election progress.

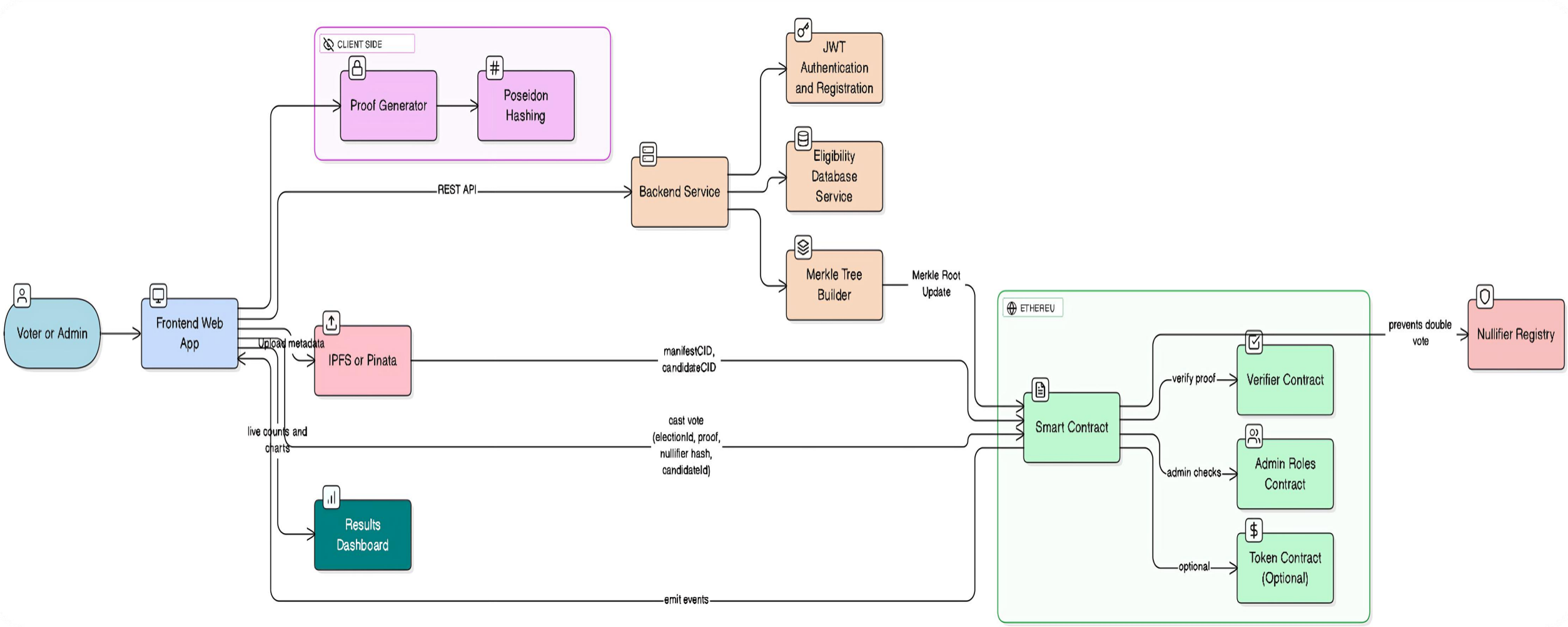
Technology used

1. **Blockchain:** Ethereum, Solidity (EkMatVoting.sol), and Ethers.js.
2. **AI (EkSaathi):** Powered by Llama 3/3.2 and Langflow for multilingual support.
3. **Storage:** IPFS and Pinata for censorship-resistant metadata storage.
4. **UI/UX:** Built with React and TypeScript for a robust, secure interface.

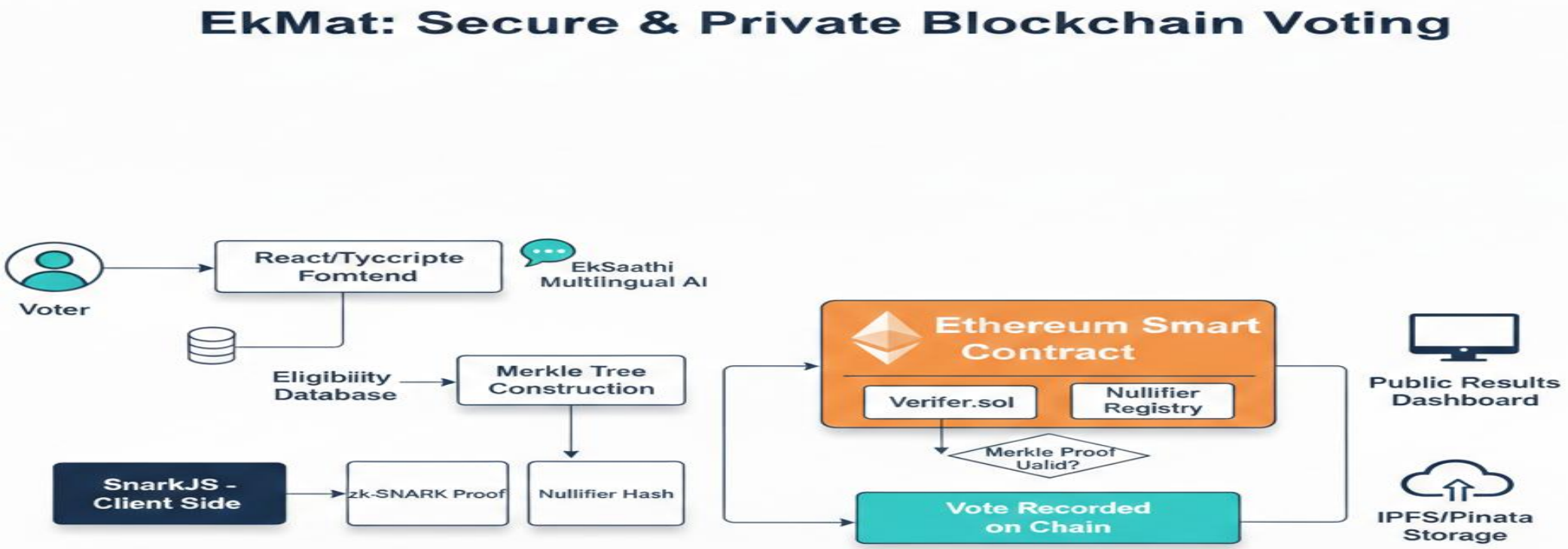
Technical flow diagram -



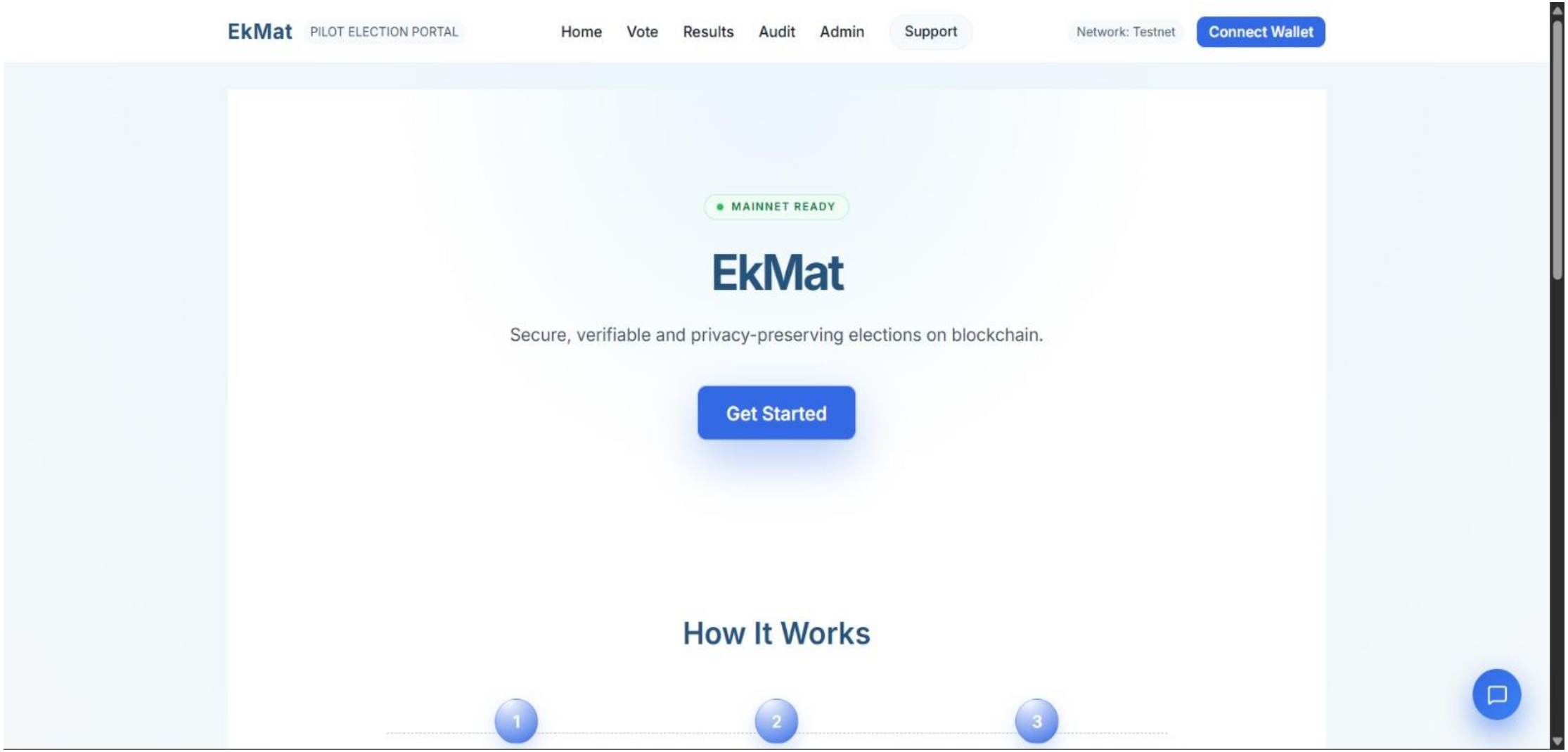
Architecture Blueprint



Workflow diagram



Screen shots of your project -



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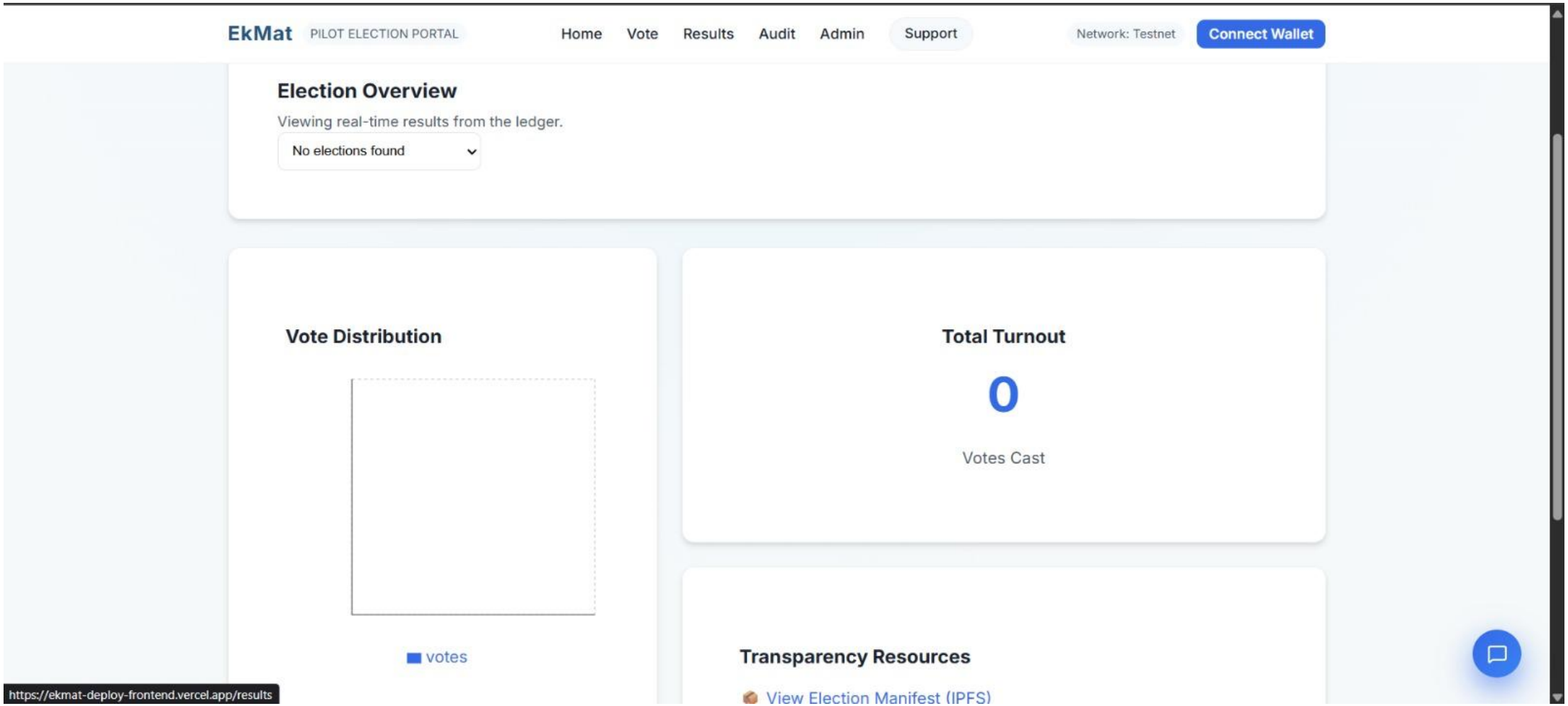

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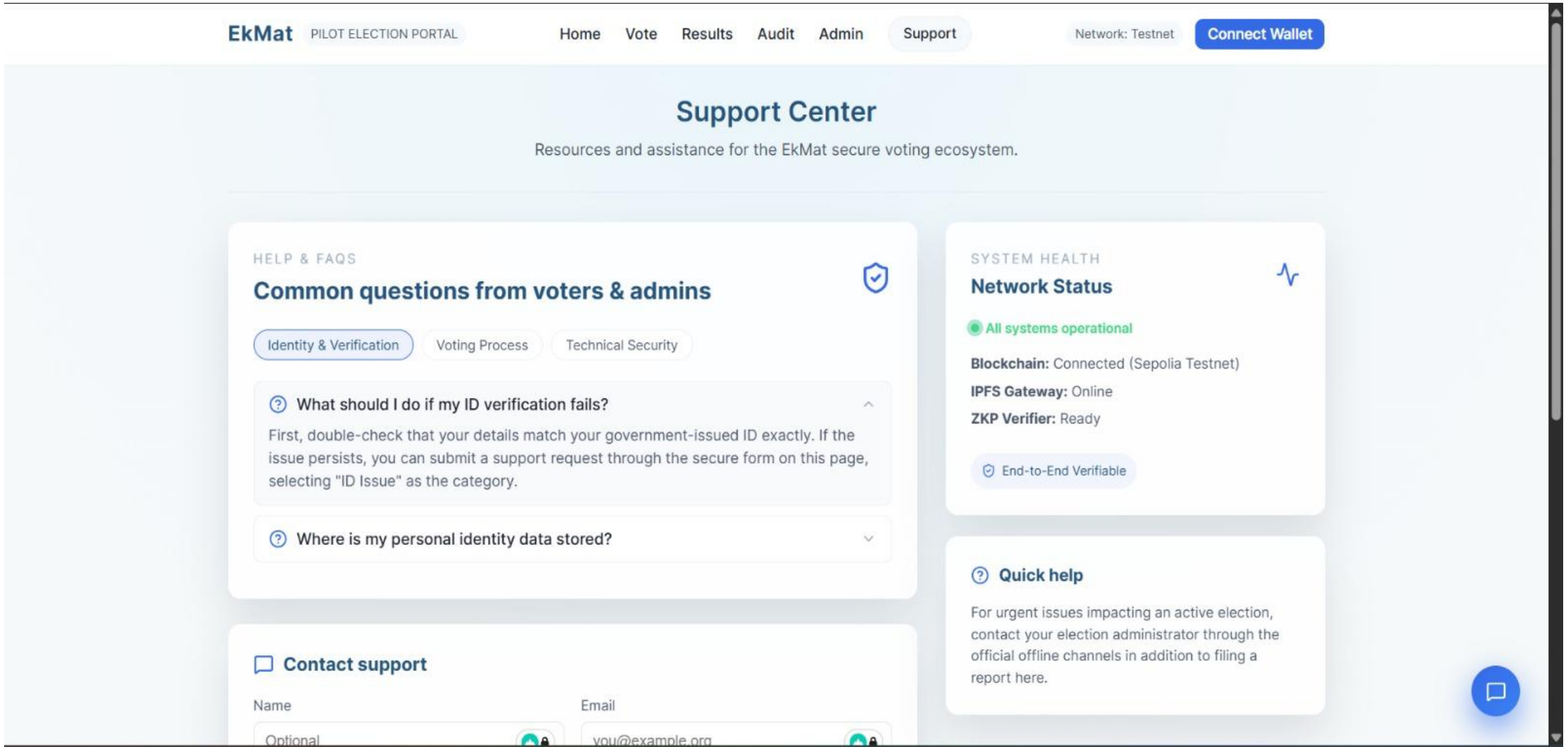

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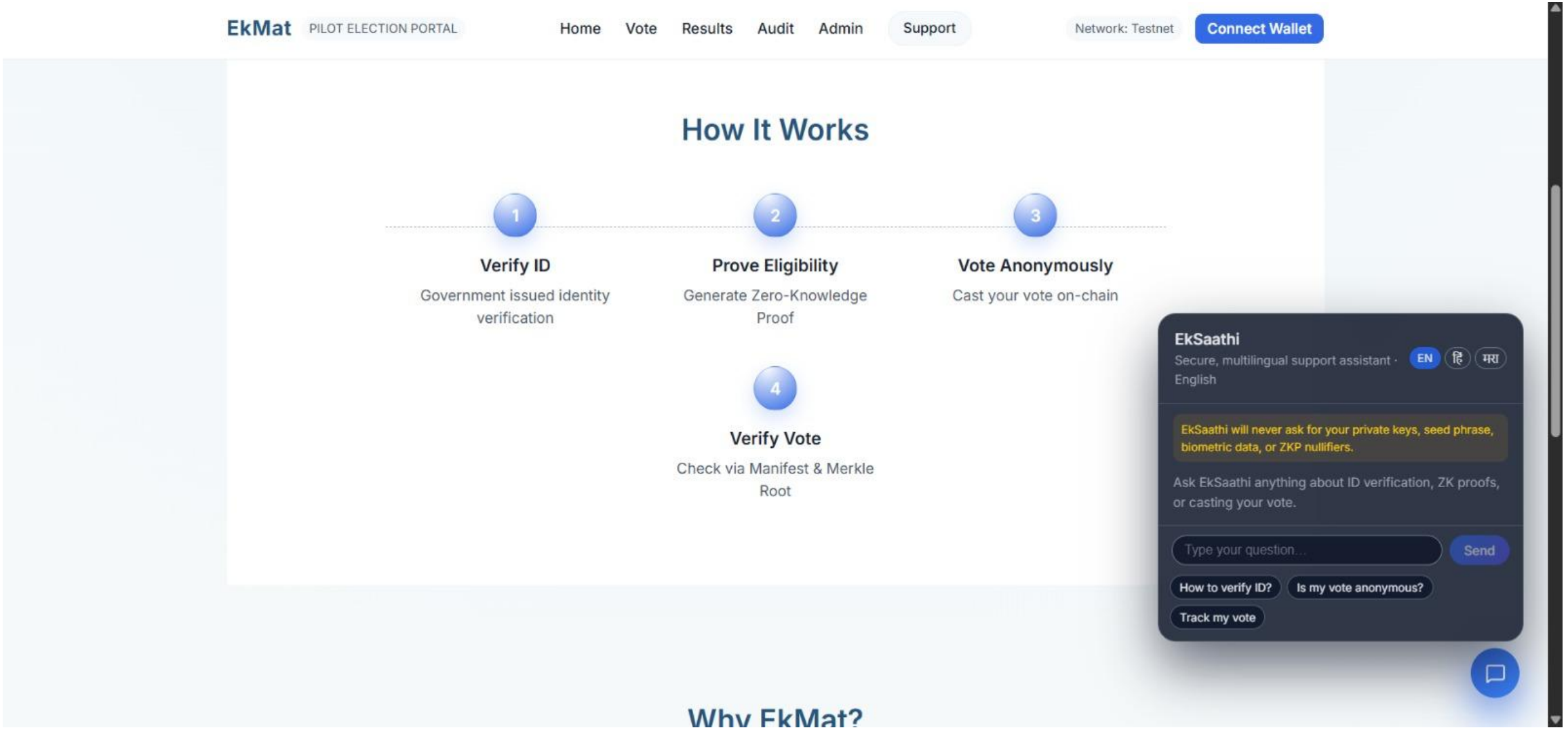
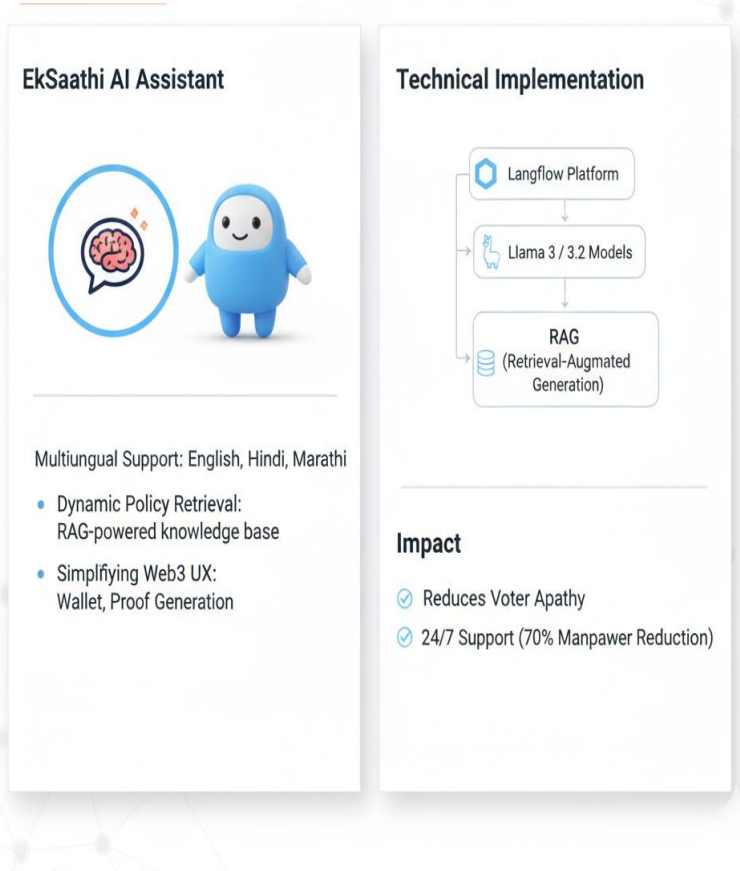


Role of Agentic AI and Gen AI in the solution

- **Multilingual Support:** Uses GenAI to provide real-time assistance in English, Hindi, and Marathi, ensuring the portal is inclusive for diverse demographics.
- **Dynamic Policy Retrieval:** Utilizes RAG (Retrieval-Augmented Generation) to fetch and explain election rules, voting procedures, and candidate information without human intervention.
- **Simplifying Web3 UX:** Acting as an "Agentic Guide," the AI helps users navigate technical steps—such as wallet connection or cryptographic proof generation—through natural language dialogue.



Novelty and Uniqueness

1

Absolute Privacy with **ZK-SNARKs** EkMat is a pioneering platform that merges **Groth16 zk-SNARKs**

2

Client-Side Security Model Unlike **centralized digital systems**, EkMat uses SnarkJS

3

AI-Driven Multilingual Inclusion The integration of **EkSaathi**

4

End-to-End Auditability Despite total privacy, every step of the election is recorded on the **Ethereum blockchain.**

Git Hub Link

1. **Public Repository URL:** https://github.com/ayushcody/vois

2. **Repository Status:** Public (Enabled "**Add README**" button)

3. **Mandatory Files Uploaded:**

   - **app.py:** The core application logic and backend integration for the EkMat platform.
   - **EkMat_ProblemStatement.pdf:** Detailed documentation of "The Ailing Ballot Box" and the crisis of trust in modern elections.
   - **EkMat_Presentation.pptx:** The final version of this project presentation for the VOIS Marathon 2.0.

4. **Additional Repository Contents:**

   - **Smart Contracts:** Source code for EkMatVoting.sol and Verifier.sol.
   - **ZKP Circuits:** The circom files used for generating zero-knowledge proofs.
   - **AI Agent Logic:** Orchestration files for the EkSaathi multilingual assistant.
   - **Comprehensive README:** Includes a project overview, technical architecture diagrams, and a step-by-step setup guide.

Future Scope

- **National ID Integration (Aadhaar):**Transition from manual verification to automated, cryptographically secure identity checks by integrating with the Aadhaar ecosystem. This will streamline the "Know Your Voter" (KYV) process while maintaining privacy through Zero-Knowledge identity bridging.

- **Layer 2 (L2) Scaling & Batching:**To handle the throughput required for national-level elections, the platform will leverage L2 Rollups (such as zkSync or Arbitrum). This allows for batching thousands of votes into a single on-chain transaction, drastically reducing gas costs and increasing speed.

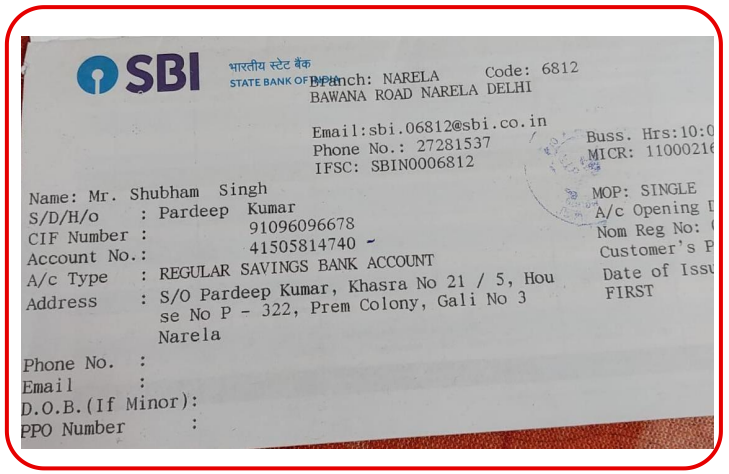
- **Mobile-First & Offline Support:**Development of a dedicated mobile application designed for low-bandwidth environments. Future iterations will explore "offline-first" cryptographic voting, where votes are signed locally and synced once a connection is established, ensuring inclusivity for rural populations.

- **Decentralized Governance (DAO):**Establishing a Decentralized Autonomous Organization (DAO) to manage the platform's evolution. This ensures that future changes to voting protocols, candidate lists, and system updates are decided by the community rather than a single central authority.

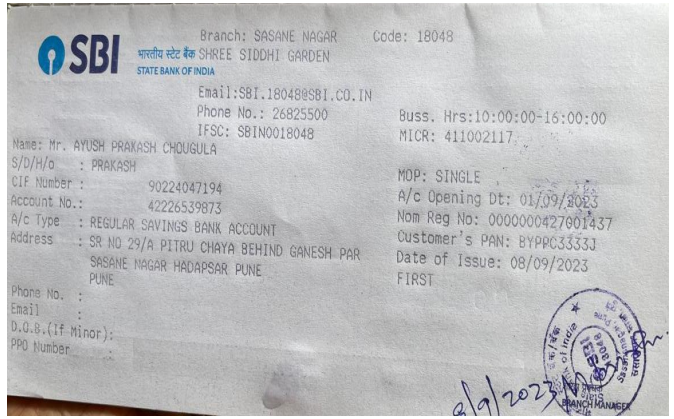
- **Expanded AI Capabilities:**Enhancing EkSaathi to support more regional dialects and accessibility features (such as voice-to-vote for the visually impaired), making the democratic process truly barrier-free.

Bank Details

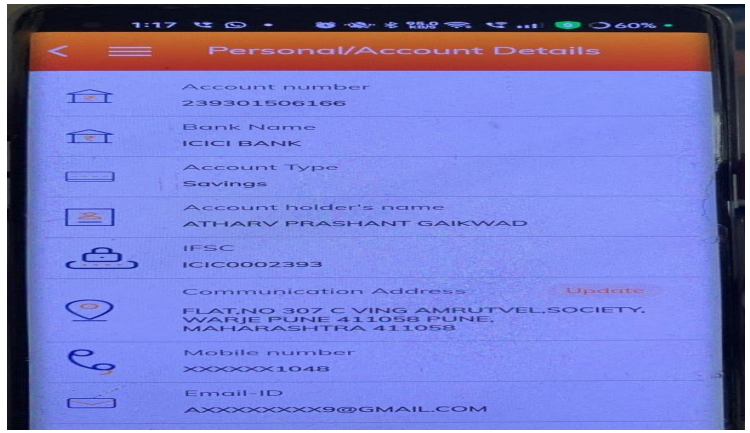
Full Name (as per bank records):	Bank Name	Branch Name	Account Number	Account Type (Savings / Current)	IFSC Code
Shubham Singh	State Bank Of India	NARELA DELHI,Code: 6812	41505814740	SAVINGS	SBIN0006812
Ayush Prakash Chougula	State Bank Of India	SASANE NAGAR, Code: 18048	42226539873	SAVINGS	SBIN0018048
Atharv Prashant Gaikwad	ICIC Bank	WARJE PUNE	239301506166	SAVINGS	ICIC0002393



Team Member 1



Team Member 2



Team Member 3

Thank You