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E- VOTING SYSTEM USING BLOCKCHAIN TECHNOLOGY

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ABSTRACT

An e-voting system using blockchain technology ensures secure, transparent, and tamper-resistant elections. By utilizing the decentralized nature of blockchain, it eliminates the risk of single-point failures, fraud, and vote manipulation. Voter anonymity is preserved through cryptographic techniques, while each vote is securely recorded and verifiable on the blockchain. This system enhances trust in electoral processes by providing real-time auditability and ensuring that all votes are counted accurately. It also allows remote voting, increasing voter participation while maintaining the integrity of the election

Keywords: Blockchain, Voting, Ethereum, Smart Contract, MetaMask

I. INTRODUCTION:

Many elections conducted on electronic voting machines are hand-counted, and many jurisdictions that use lever voting machines tally absentee ballots by hand. Because these devices are not meant to endure a long time, they must be serviced on a regular basis by only trained mechanics. Apart from equipment maintenance issues, there has also been a problem with only a small fraction of individuals voting. For verification, most present E-voting applications rely on government-issued information, which is not the most effective means of authentication. Because when we have to store large amount of sensitive information in the local database, it is difficult to keep it secure. There is also the possibility of casting multiple ballots. To address these issues, the suggested solution includes a decentralized database and a smart contract, which allow voters avoid casting duplicate ballots.

Blockchain technology emerged with the advent of cryptocurrencies like Bitcoin, but its applications extend far beyond financial transactions. At its core, blockchain is a decentralized, distributed ledger that records transactions across multiple computers. This decentralization enhances security by reducing the risk of single points of failure, making it difficult for malicious actors to alter or tamper with data. Blockchain technology enables decentralized online voting systems, offering a platform that is transparent, secure, and efficient for the execution of elections. By leveraging Blockchain's properties, including immutability and decentralization, these systems aim to enhance trust and integrity in the voting process. Through cryptographic techniques, eligible voters can securely cast their votes, which are recorded as transactions. The elimination of intermediaries reduces costs and streamlines the voting process, while also promoting inclusivity and accessibility. While challenges remain, decentralized online voting systems have the potential to revolutionize elections by ensuring transparency, security, and democratic participation. The domain of **e-voting systems using blockchain technology** focuses on creating secure, transparent, and tamper-resistant voting platforms for public and private elections. Leveraging blockchain technology, this domain aims to address key issues such as voter fraud, data manipulation, lack of transparency, and inefficiencies in traditional voting methods.

Key Elements:

1. **Blockchain Technology**:
   - Blockchain is a decentralized, immutable

ledger that records transactions in a transparent and secure manner. In the context of e-voting, blockchain ensures that every vote cast is securely stored, verifiable, and cannot be altered or tampered .

- It provides distributed consensus, meaning that multiple nodes (computers) validate and store voting data, eliminating the need for a central authority.

1. **Transparency and Trust**:
   - Blockchain allows real-time verification of votes, giving voters and election authorities the ability to verify that votes are correctly counted.
   - Since blockchain is decentralized, it increases trust by preventing any single entity from having control over the voting process, mitigating concerns of rigging or manipulation.

2. **Security**:
   - Using cryptographic techniques, each voter's identity and vote are anonymized, ensuring privacy and confidentiality.
   - The immutable nature of blockchain prevents retroactive alteration of voting data, making the system highly resistant to cyber-attacks and fraud.

3. **Efficiency**:
   - Blockchain-based e-voting systems reduce the time and cost associated with physical voting processes by enabling remote voting from any location, using digital devices.
   - The system can handle high-volume voting efficiently, ensuring rapid tallying of votes, reducing errors, and speeding up the overall election process.

4. **Smart Contracts**:
   - Smart contracts can automate certain aspects of the election process, such as verifying voter eligibility or automatically counting votes once the election period ends.
   - They ensure that election rules are strictly followed, making the process more reliable.

A smart contract is a self-imposed contract that is embedded in a blockchain managed computer code. This code includes a set of rules governing the communication and decision on the contract between the parties, the contract will be enforced automatically once the already defined rules are met. Smart contract gives a framework for efficient control between two or more parties of tokenizes assets and access rights shows the working principle of smart contract. Blockchain is just a database that cannot be altered, without smart contract, which expands and leverages blockchain. There are various aspects of smart contract including technical aspect, legal aspect, economic aspect, that can be seen from the Self-verification of the conditions in a smart contract is done by data interpretation. Each network node will guarantee the proper execution of a single contract, which relief the contract creators from tracking the execution of the contract. Smart contracts are self-executing, where the conditions of the agreement between different parties are written into the code. This means that legal obligations can be mapped using smart contracts into automated process. The execution of the contract can be automatically invoked by a trigger like expiration date.

In this paper, we implement blockchain based e-voting system which overcome the problems encountered in e-voting and builds trust among voters for legitimate voting. Moreover, it will also be a helpful step towards the development of smart governance.

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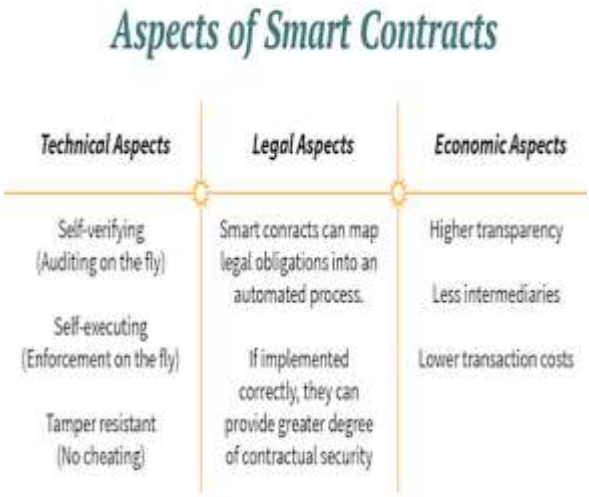

Figure 1: Smart Contract

II. EXISTING SYSTEM

The Electronic Voting (e-Voting) has effectively replaced the traditional paper-based voting system. The Electronic Voting System aids the voter to cast his vote through a digital or an electronic medium. The Electronic Voting is implemented through Electronic Voting Machines (EVM), Short Messaging Service (SMS) using Smart Phones, Remote or Internet Voting over Internet, etc. Electronic Voting is a system which helps the voter to record his choice for a particular candidate securely and privately. The e-voting system is an integrated system designed using a micro controller which generates the results based on the opinion of the people

The Election process is made simple using Electronic Voting System. The first procedure involves logging into the website with the voters registered details. Then the user or voter selects a candidate according to his personal choice. This is called submission of ballots digitally. The system records the details and stores the voter's information in the database and computers help in counting and displaying voter's results. Most popular type of Electronic Voting includes Electronic Voting Machines (EVM) and recording votes via telephones, private computer networks, or the Internet (i-Voting) using a smart phone.

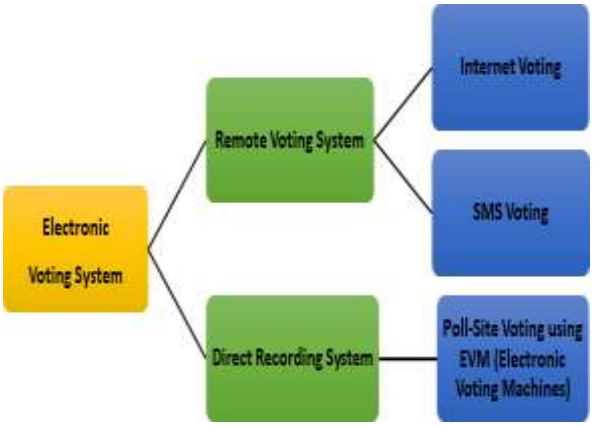

Figure 2: Internet Voting System (Remote Voting) Architecture

❖ **Disadvantages :**

Security Vulnerabilities: Without blockchain, e-Traditional voting systems face several key challenges, including:

- Lack of Transparency: Voters often have limited visibility into how votes are counted and processed. This can lead to mistrust in election outcomes.
- Security Threats: Traditional electronic voting systems are vulnerable to hacking, tampering, or manipulation.
- Centralization: Centralized systems create a single point of failure, where an attack or breach could compromise the entire system.
- Voter Fraud: Risks of identity fraud, double voting, and fake registrations remain prevalent in various voting methods.
- Accessibility Issues: Voters may face challenges in reaching polling stations or may be restricted by geography or mobility
- High Costs: The cost of maintaining secure, reliable, and scalable voting infrastructure is high for both electronic and paper-based systems.
- Delayed Results: Manual vote counting can lead to delays in publishing results, causing public frustration and uncertainty.

III. PROPOSED SYSTEM

To address the challenges identified in traditional voting systems, a blockchain-based e-voting system is proposed. This system leverages

blockchain's decentralized and immutable nature, offering a secure, transparent, and cost-efficient platform for elections. The proposed solution incorporates modern cryptographic techniques, distributed ledger technology, and smart contracts to build an end-to-end e-voting solution that guarantees the integrity and privacy of votes while enhancing voter participation and confidence.

❖ **Key Components of the Solution**

1 Blockchain Network

The foundation of the system is a permissioned blockchain network where trusted nodes (such as government authorities, election commissions, and independent auditors) manage the consensus mechanism. This ensures the integrity of the voting process while keeping the system decentralized and resilient to single points of failure.

- **Decentralization**: The distributed nature of blockchain ensures that there is no central authority controlling the voting process, reducing the risk of fraud or tampering.
- **Immutable Ledger**: Every vote is stored on a secure, immutable ledger, ensuring that once a vote is recorded, it cannot be altered or deleted.

i. Smart Contracts

Smart contracts are automated, self-executing programs that enforce rules and processes within the system. They will be used to govern the e-voting process, from voter registration to vote tallying, without human intervention. Smart contracts will handle:

- **Voter Authentication**: Automatically verifying the identity of voters and ensuring eligibility (age, citizenship, etc.).
- **Vote Casting**: Recording votes on the blockchain securely and transparently while ensuring that each voter can cast only one vote.
- **Vote Tallying**: Real-time vote counting as the blockchain records votes immediately after casting.

ii. Voter Authentication & Anonymity

A crucial aspect of the system is the ability to authenticate voters without compromising their anonymity. The system will use cryptographic techniques to ensure that:

- **Voter Identity is Verified**: Using government-issued IDs, biometrics, or a public key infrastructure (PKI), voters are verified before voting.
- **Anonymous Voting**: The system will incorporate cryptographic techniques like homomorphic encryption or zero-knowledge proofs to ensure the votes are anonymous, so no one can link a vote to a specific voter.

iii. Distributed Voter Registration System

The voter registration process will also leverage blockchain to maintain a decentralized, tamper-proof database of eligible voters. Voters will be registered on the blockchain using an encrypted digital ID, which can be verified during the voting process

iv. Transparency and Auditability

Blockchain's transparency allows every vote to be verifiable by both voters and third-party auditors. This means that:

- **Public Verification**: Anyone can verify the total number of votes cast and tallied on the blockchain without accessing individual voter identities.
- **Audit Trail**: The system will generate a complete audit trail of all transactions, making it

impossible to tamper with the election process undetected

v. **User Interface for Voters**

To make the system accessible to all eligible voters, a user-friendly interface will be developed, allowing voters to:

- **Register** securely on the platform.
- **Cast their Vote** by selecting their candidate from a list, and confirm submission.
- **Track Vote** submission to ensure their vote was recorded successfully on the blockchain (without revealing which candidate they voted for).

2 System Workflow

- **Voter Registration**: Voters register on the blockchain-based system with their verified identification, receiving a unique digital ID.
- **Voting Period**: During the voting period, voters log into the system using secure authentication, cast their vote, and receive a receipt of submission.
- **Vote Submission**: The vote is immediately encrypted and recorded onto the blockchain through a smart contract, ensuring it cannot be altered
- **Vote Counting**: The blockchain automatically tallies votes in real time, and the results are visible to authorized stakeholders without compromising individual vote secrecy
- **Results Publication**: After the voting period ends, the results are published instantly, with all parties able to verify the authenticity of the count.

The proposed system utilizes several tools namely ganache, truffle framework, npm and MetaMask. Truffle imports the smart contracts on the blockchain while as ganache operates the internal blockchain and it will be accessed by using MetaMask. With some Ether i.e. Ethereum's cryptocurrency is required by a user for an account with wallet address. To write the transaction to blockchain, user needs to pay a certain transaction fee which is called as gas. Once votes are cast the process is completed by a number of nodes on the network called as minners. These miners compete with each other to complete the transaction. The miners who succeed in this transaction is awarded ether paid by users to vote. Instead of node we will be using ganache software for mining purpose

Truffle:

Truffle is a tool that makes it easy for designers to build blockchain-based applications with respect to Ethereum. It allows designers to build and test solid contracts and create public and private organizations that use regional languages such as JavaScript. A remarkable and attractive feature about Truffle is its command line tool. We can use a variety of important commands, for example, assemble, move, repair, etc. The control center is a quick and easy way to connect with the blockchain.

Ethereum and Ethers:

Ethereum is an open source platform based on blockchain innovation standards. The main advantage of Ethereum is that it allows developers to assemble and submit fixed applications. Ethereum assists designers by performing tasks based on their needs, and this means that developers can build many different applications. Ethereum uses nodes to replace individual cloud compounds and servers demanded by essential Internet services. These nodes are managed by volunteers. This will help to provide a framework for people all over the world. The glorified Ethereum model is the only one that will not help itself against hacking and closure, as no feature will have authority over your personal information.

Ether is the sender of a computer service as collateral or bond and is a solution to the instalment issue. Ether acts as a currency as it does not require an outsider to support or manage the

transaction. However, Ether is not really a digital currency. It is often considered a fuel for Ethereum organization applications.

Web3.js:

Web3.js is a visual interface for the Program with a large JavaScript library, which allows developers to accept their smart contracts. Depending on the complexity of the Divided Applications application, a designer may incorporate complex conclusions by designing Java driven dynamic projects or even familiarize themselves with their dedicated application experience with Python-coded intelligence-related projects. This is linked to our nationally distributed blockchain application with a conference called JSON RPC. One can no doubt connects with everything directly in the order line by performing a Web3 even.

MetaMask:

MetaMask is a simple crypto wallet. MetaMask can assist designers in testing and evaluating dApp transactions. MetaMask successfully collaborates with a local blockchain operating engine. Inside your Truffle console, duplicate your localhost hole, and paste it into a custom RPC accessible for system extension. Records can be successfully imported from Truffle to MetaMask has been an amazing and well-known commitment to the Ethereum biology system. Developers can undoubtedly switch between blockchains. In the event that the client visits dApp, MetaMask acts as a blockchain mediator. The MetaMask GUI is also very easy to use. It consistently connects the client with the blockchain. MetaMask notifies the client to support the exchange. This and other exchanges are a fee that a client may pay in other cryptographic fees to associate with a blockchain MetaMask has been an incredible and well known commitment to the Ethereum biological system. Developers can undoubtedly switch between blockchains. At the point when a client visits a dApp, MetaMask goes about as a mediator of the blockchain. MetaMask. GUI is likewise extremely easy to use. It associates a client to the blockchain consistently. MetaMask prompts a client to support an exchange. This exchange is here and there just a charge a client may pay in some cryptographic money to associate with the blockchain.

Ganache:

Ethereum smart contracts are programs executed inside the setting of exchanges on the Ethereum blockchain. Ethereum Ganache frames part of the Truffle Suite, a bunch of engineer devices that permits clients to reproduce blockchain conditions locally and test savvy contracts. Ethereum Ganache is a neighbourhood in-memory blockchain intended for improvement and testing

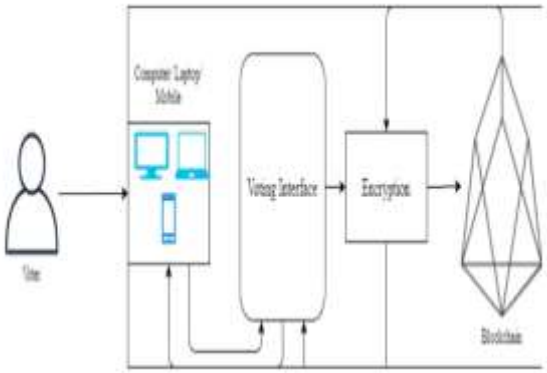

Figure 3: Proposed E-Voting System Based on Blockchain

3. Advantages:

- Authentication: Only registered voters will be allowed to vote.
- Anonymity: The system prevents any interaction between the votes casted by the voters and their identities.
- Accuracy: Votes once cast are permanently recorded and cannot be modified or changed under any circumstances.
- Verifiability: The system will be verifiable such that the number of votes is accounted

3 DESIGN & IMPLEMENTATION

The E-Voting System using Blockchain Technology is designed to revolutionize the traditional electoral process by leveraging the decentralized, secure, and transparent nature of blockchain. This system ensures the integrity,

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confidentiality, and accessibility of votes, addressing the prevalent challenges in conventional voting mechanisms such as fraud, tampering, and inefficiencies.

The overall working of proposed system whereby a voter goes to the system, gets registered as well as received voter ID which helps him/her to go to a designated voting station consisting of *MetaMask* browser where account was created and interact with the front end and select a desired candidate. Here, ether is transferred to the wallet of the candidate.

Smart contract contain logic of election where raw transaction object is created generating hash value that can be signed using private key as well as validate transaction after which block is created by miner and broadcast to the entire node in the blockchain.

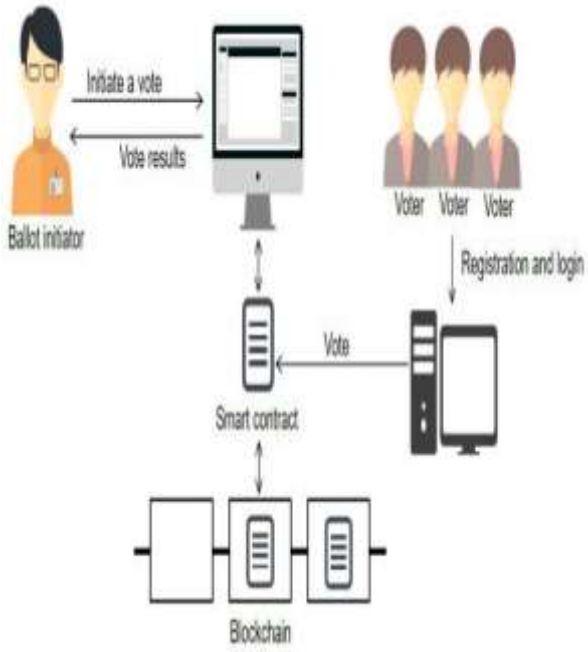

Figure 4 : System Architecture

3.1 Modules

E-Voting using Blockchain Technology, you can divide the system into two primary modules: the User Module and the Admin Module. Here is a detailed description of each module:

1. **User Module**

This module handles the interaction between voters and the e-voting platform. The key features and functionalities include:

Key Features

1. **User Registration :**
   - Voters must register with the system by providing a valid ID (e.g., voter ID or national ID) and personal details.
   - Two-factor authentication (e.g., OTP-based or biometric authentication) can be implemented to ensure security
   - Blockchain will record the registration information to ensure transparency and immutability.

2. **Voting Process:**
   - Voters can view a list of available elections and select one to vote in.
   - The user selects their preferred candidate/option, and the vote is cast anonymously.
   - Blockchain ensures that each user can vote only once, maintaining vote integrity and preventing tampering or multiple voting attempts.

3. **Vote Confirmation & Transparency**
   - After voting, the system generates a unique receipt that can be used by voters to verify that their vote was counted correctly, without revealing the vote & content.
   - The blockchain allows voters to track the voting process transparently, ensuring that their vote has been added to the ledger securely and has not been altered.

4. **Security and Anonymity:**
   - The system ensures voter anonymity and privacy by encrypting each vote on the blockchain.
   - The decentralized nature of blockchain helps in protecting the system from hacks and data

manipulation.

Functionalities:

- The user first visits the site where they have to cast the vote
- Apply Candidate In this module, public users who are willing to apply for candidate can apply here by providing required details. All applied candidate can be elected as candidate. Admin only approve candidate
- QR Scanning After the QR Coin is generated, the user can view the site only at the particular date and time and only at this time the user can view and access and the user can scan QR .
- QR Reading In this project we can read our QR code by browsing and add QR image into our QR reader. We have alternative QR reading technology by using the scanner. Once we scan the QR and submit it into the QR reader the scanned image will be retrieved and the user can see the information provided in the decrypted QR.
- Polling After the QR is scanned, the user can poll votes. The user can view to whom they want to vote and poll accordingly and the voting details are viewed with database security using Encryption process. The voting process is now more secured.
- Database cryptography In this module, when all the votes are collected, they are stored in database after QR scanning. Each votes are scanned and stored in database after encryption so that authentication becomes even more secure. For this database security, Blockchain technology is used

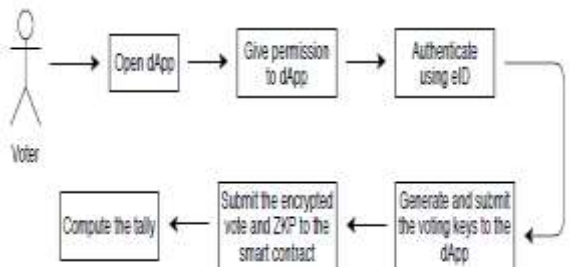

Figure 5 : Flowchart regarding the Voting process of e- voting system

ii. Admin Module

This module allows administrators to manage elections and oversee the voting process. The key functionalities include:

Key Features

1. **Election Management:**
   - Admins can create new elections, set the start and end dates, and manage candidate lists
   - Admins are responsible for ensuring all eligible voters are registered before the election starts.
   - Election rules and conditions can be configured, such as the required voter criteria, secret balloting, or open voting processes.

2. **Vote Counting and Results:**
   - The blockchain automatically tallies the votes in real-time. Admins can monitor the voting process but cannot alter or tamper with the votes.
   - At the end of the election, the system automatically calculates the results and presents them in a secure, tamper-proof manner
   - Results can be shared with the public in real-time or after the voting period closes, depending on the election setup.

3. **Security and Audit Trails:**
   - Admins can review the entire voting history through blockchain's immutable ledger, ensuring there are no discrepancies.
   - The blockchain ledger allows for transparent audits, where any third party can verify the results and the process without compromising voter privacy.

Functionalities

1. Manage Voter Details In this module, the user can add voter list and the admin only can access voter details and can update the voter details as and when necessary.
2. Generate QR Coin After adding the details, QR Coin is generated and distributed to the particular user. Only that particular user can view the details and at particular date and time. Only with that QR Coin only the user can cast votes.
3. Manage Candidate details In this modules, all applied candidate details will be managed. Admin can approve only particular candidate. And Party symbols will be allocated by admin to approved candidates.

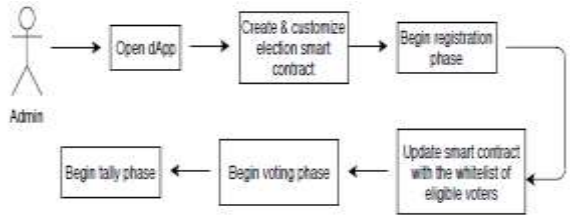

Figure 6:Flowchart regarding the Voting process of e- voting system

IV. RESULTS

The implementation of an e-voting system based on blockchain technology aims to enhance the security, transparency, and efficiency of the electoral process. This section presents the results obtained from the deployment and testing of the system, highlighting its performance in key areas such as security, user experience, and operational effectiveness. By leveraging blockchain & decentralized nature, the system ensures that votes are immutable and verifiable, thereby addressing common challenges associated with traditional voting methods, such as fraud, tampering, and lack of transparency. The results demonstrated not only the feasibility of using blockchain for secure voting but also provided insights into the overall user experience and system performance under various conditions. Through rigorous testing, including functional, security, and performance evaluations, we aimed to validate the system & capabilities and identify areas for further improvement. The following sections will detail the outcomes of these assessments, showcasing the strengths of the blockchain-based e-voting system and its potential implications for future electoral processes.

V. CONCLUSION

To overcome all the Shortcomings in the Present Voting System, we came up with the Modern Technology of Blockchain i.e. E-Voting System using Blockchain. By using this modern technology, following things can be Achieved: - Cheap Voting System, Accurate Voting System, and Fast Voting System. Every Citizen desires to have a Transparent and Direct Form of Democracy which is clear cut obtained from this E- Voting System using Blockchain. Faith of People on the Voting System is increased therefore, many People Come Forward for Voting, thereby increasing the Percentage of the People Voted. The Pen and the Paper Election is Eradicated thereby creating Accuracy in the Voting System. Everybody Prefers Time, and Cost Efficient Systems so this E-Voting System using Blockchain is apt for Transparent Democracy. Ethereum Private Blockchain allows hundreds and hundreds of Transactions in a Second. Utilization of the Smart Contracts lowers the Load on the Blockchain. For Countries with Greater Population, some additional Technology should be added in this E-Voting System using Blockchain to avoid Errors. The main reason behind this system is to present an idea of implementation of blockchain in the voting system.

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