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# AN EFFICIENT VOTE CASTING SYSTEM WITH AADHAR VERIFICATION THROUGH BLOCKCHAIN

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**ABSTRACT**

The rapid growth of digital technologies has created new opportunities to modernize traditional voting systems by improving transparency, security, and efficiency. This paper proposes an efficient electronic vote casting system that integrates Aadhaar-based identity verification with blockchain technology to ensure secure and tamper-proof elections. Aadhaar authentication enables accurate voter identification and prevents duplicate or fraudulent voting, while the decentralized nature of blockchain maintains immutable records of each vote. Smart contracts are used to validate voter eligibility and securely record transactions without relying on a centralized authority. The proposed system enhances trust, privacy, and auditability by providing end-to-end encryption and transparent vote tracking. Experimental analysis demonstrates that the framework reduces operational complexity, minimizes human intervention, and ensures reliable election processes. This approach has the potential to transform digital voting by delivering a secure, scalable, and transparent solution for modern democratic systems.

## I INTRODUCTION

The advancement of digital technologies has significantly influenced the evolution of traditional governance systems, including the electoral process. Conventional voting methods often face challenges such as voter fraud, lack of transparency, long processing times, and high operational costs. Electronic voting systems have emerged as a potential solution, but concerns related to security, data tampering, and voter identity verification continue to limit their widespread adoption. To address these issues, integrating reliable identity authentication with secure data management technologies has become essential.

Aadhaar, as a unique biometric-based identification system, offers a strong mechanism for verifying voter identity and preventing duplicate or unauthorized voting. However, centralized databases used in many digital voting systems remain vulnerable to cyber attacks and manipulation. Blockchain technology introduces a decentralized and immutable ledger that ensures transparency, traceability, and security of transactions. By combining Aadhaar-based authentication with blockchain infrastructure, it is possible to build a voting framework that maintains voter privacy while guaranteeing the integrity of election data.

This proposed efficient vote casting system aims to enhance trust in digital elections by leveraging secure authentication, cryptographic validation, and distributed record-keeping. The integration of smart contracts automates eligibility verification and vote recording, reducing human intervention and minimizing errors. Overall, the system seeks to provide a scalable,

transparent, and tamper-resistant solution that can support modern electoral requirements and strengthen democratic processes.

## II RELATED WORK

Several researchers have explored the integration of blockchain technology and digital identity verification to enhance the security, transparency, and efficiency of electronic voting systems. Traditional voting methods often suffer from issues such as vote manipulation, lack of transparency, and identity fraud, which motivated the development of blockchain-based voting frameworks.

Early studies on electronic voting emphasized the need for secure voter authentication and reliable vote recording mechanisms. Researchers proposed cryptographic and biometric verification techniques to prevent ballot stuffing and ensure voter authenticity. For example, secure end-to-end verifiable voting models introduced biometric authentication to strengthen identity verification and reduce fraud risks.

Recent research has focused on blockchain as a decentralized ledger that can provide immutable, transparent, and tamper-resistant election records. Technology review papers highlight that blockchain improves trust and reduces dependence on centralized authorities, though challenges such as scalability, privacy, and transaction speed still remain. Studies also show that blockchain-based e-voting systems allow remote participation and reduce operational costs, but they must address cybersecurity risks and infrastructure limitations.

Several proposed systems combine blockchain with Aadhaar or biometric verification to enhance voter identification. Research on Aadhaar-based blockchain voting frameworks demonstrates that integrating unique digital identity with decentralized ledgers can improve voter authentication accuracy while maintaining transparency and security. Other works explore advanced biometric and cryptographic approaches, showing that combining identity verification with blockchain enhances auditability and prevents impersonation attacks.

Additionally, comparative surveys of blockchain voting mechanisms analyze different architectures, cryptographic methods, and consensus models to improve efficiency and scalability. These studies highlight the importance of smart contracts, secure key management, and privacy-preserving protocols in designing next-generation voting systems.

Despite significant progress, existing solutions still face challenges related to large-scale deployment, voter privacy, and system performance. Therefore, this proposed efficient vote casting system aims to combine Aadhaar-based verification with blockchain technology to provide a more secure, scalable, and transparent digital election platform.

## III LITERATURE REVIEW

The concept of electronic voting has evolved significantly with the integration of modern technologies such as blockchain, biometrics, and distributed systems. Early research focused on developing secure online voting platforms that could replace traditional paper-based methods. These systems mainly relied on centralized databases and cryptographic techniques to protect voter information. Although they improved efficiency, many studies identified security vulnerabilities, lack of transparency, and risks of data manipulation due to centralized control.

With the emergence of blockchain technology, researchers began exploring decentralized voting models to address these limitations. Blockchain-based voting systems provide an immutable ledger where

each vote is recorded as a secure transaction, ensuring transparency and preventing unauthorized alterations. Several studies highlighted the advantages of smart contracts in automating voter eligibility checks and maintaining tamper-proof election records. However, issues related to scalability, transaction speed, and privacy preservation were also discussed as significant challenges in large-scale elections.

Biometric authentication methods, including Aadhaar-based verification, have been proposed to strengthen voter identification processes. Literature shows that combining biometric identity with blockchain enhances security by preventing duplicate registrations and impersonation attacks. Researchers emphasized that Aadhaar integration enables reliable digital identity management while blockchain ensures decentralized storage and auditability. Some frameworks introduced multi-factor authentication mechanisms, combining biometric data with one-time passwords or cryptographic keys to further improve system reliability.

Recent studies have also investigated privacy-preserving techniques such as zero-knowledge proofs, encryption algorithms, and secure hashing to protect voter anonymity while maintaining transparency. Comparative analyses of existing e-voting platforms reveal that hybrid architectures — integrating blockchain, biometric verification, and secure cloud infrastructure — provide better performance and trustworthiness compared to traditional systems.

Overall, the literature indicates that while blockchain-based voting with Aadhaar verification offers promising solutions for secure and transparent elections, further improvements are required in terms of scalability, user privacy, regulatory compliance, and system usability. The proposed efficient vote casting system builds upon these existing research contributions by combining secure identity verification with decentralized blockchain architecture to deliver a reliable and efficient digital voting framework.

## IV EXISTING SYSTEM

In India, traditional voting systems have evolved from paper ballots to Electronic Voting Machines (EVMs), yet several challenges remain in ensuring transparency, security, and voter trust. The current electoral process relies on centralized databases managed by election commissions, where voter identities are verified through voter ID cards and manual authentication at polling booths. Election officers manually verify voter details against printed electoral rolls and maintain physical records of turnout. EVMs store votes locally on devices later transported to counting centers, requiring extensive logistical coordination. Despite technological advancements, the system remains dependent on manual intervention at multiple stages.

Due to the lack of decentralized automation, the existing voting system suffers from several procedural inefficiencies. Voter records are often outdated or inconsistent, making it difficult to maintain accurate electoral rolls and prevent duplicate registrations. Election officials perform repetitive tasks such as manual voter verification, managing polling station logistics, and coordinating EVM transportation. There is no mechanism for voters to verify that their vote was recorded correctly, raising concerns about transparency and trust. Communication gaps between election commissions, polling officers, and voters are common, as information relies on physical notices and media announcements.

Reports and analytics are also limited in the existing electoral framework. Election performance metrics, such as voter turnout rates, booth-wise statistics, and real-time counting updates, are not generated in real time and require significant manual effort to compile from multiple sources after polling concludes. This lack

of visibility hinders effective monitoring and delays result declaration, reducing transparency for all stakeholders.

**DISADVANTAGES**

The current voting system suffers from several critical limitations that affect its reliability and effectiveness. One major disadvantage is the heavy dependence on manual processes such as verifying voter identities against printed electoral rolls, managing EVMs physically, and manually counting votes. This increases the chances of human errors, data discrepancies, and delays in result declaration. Additionally, the absence of a decentralized platform makes it difficult for voters, election officials, and auditors to access accurate and real-time voting data, leading to concerns about electoral integrity and trust.

Another significant drawback is the vulnerability to tampering and fraud, as centralized databases and standalone EVM devices are susceptible to cyberattacks, hardware malfunctions, and unauthorized access. The existing system also struggles with scalability when the number of voters and polling stations increases, creating additional workload for election staff and logistical challenges. Furthermore, the lack of remote voting options excludes millions of eligible voters, including migrant workers and overseas citizens, limiting democratic participation.

**V PROPOSED SYSTEM**

The proposed Efficient Vote Casting System with Aadhaar Verification through Blockchain is a secure, decentralized platform designed to automate and enhance the entire digital voting process. The system connects voters, election officials, and auditors through a single integrated interface, enabling efficient voter authentication, secure vote recording, and transparent result management. Voters can register using their Aadhaar credentials, authenticate through biometric verification, and cast their votes securely through the blockchain-based interface. This reduces manual intervention and ensures that each eligible voter can participate with confidence.

Election officials are provided with tools to manage voter records, verify eligibility automatically through Aadhaar authentication, schedule election dates, and monitor voting progress through real-time dashboards and reports. Voters can securely cast their votes, view candidate details, and verify their vote status through the platform. The system incorporates smart contract-based filtering mechanisms to validate voter eligibility and prevent duplicate voting, improving the accuracy and integrity of the electoral process.

Security and data privacy are ensured through blockchain encryption, role-based authentication, and controlled access mechanisms. The system also includes analytics features to track voter turnout, real-time voting statistics, and election performance, enabling data-driven decision-making. By eliminating paperwork, minimizing communication gaps, and automating critical tasks, the proposed system enhances efficiency, transparency, and scalability. Ultimately, it provides a secure, user-friendly solution that modernizes digital voting and strengthens trust in democratic processes.

**ADVANTAGES**

The proposed blockchain-based voting system with Aadhaar verification offers numerous benefits by automating and securing the digital voting process. It significantly reduces manual work by digitizing voter registration, Aadhaar-based authentication, vote casting, and result tabulation, thereby saving time and minimizing human errors. The system improves communication among voters, election officials, and

auditors through real-time notifications and a unified platform, ensuring that important updates are delivered efficiently.

Smart contract-based verification mechanisms help authenticate voter eligibility and prevent duplicate voting, increasing electoral integrity and trust. Additionally, the platform enhances transparency by allowing voters to verify their vote status and track election progress. Blockchain encryption and role-based access control ensure data security and privacy, while analytics and reporting features enable election commissions to make informed decisions using voter turnout statistics and performance insights.

Overall, the system increases operational efficiency, reduces paperwork, enhances user experience, and provides a scalable solution capable of handling large volumes of voting activities in modern democratic elections.

## VI METHODOLOGY

The proposed efficient vote casting system with Aadhaar verification through blockchain is designed to provide a secure, transparent, and tamper-resistant digital voting framework. The methodology combines biometric authentication, cryptographic techniques, and decentralized blockchain infrastructure to ensure reliable election processes. The overall workflow consists of voter registration, identity verification, vote casting, blockchain validation, and result generation.

### 1. System Design and Architecture

The system follows a decentralized architecture where blockchain acts as the core data storage layer. A web or mobile interface allows voters to interact with the system, while smart contracts handle authentication and vote validation automatically. The design ensures that no single authority can manipulate voting records, thereby improving trust and transparency.

### 2. Aadhaar-Based Voter Authentication

The first step involves verifying voter identity using Aadhaar authentication. Each voter registers with a unique Aadhaar ID linked to biometric or OTP-based verification. The system checks eligibility criteria such as age and voter status before allowing access to the voting portal. This process prevents duplicate registrations and reduces impersonation risks.

### 3. Secure Vote Casting Process

Once authentication is completed, the voter can select a candidate through a secure digital interface. The vote is encrypted using cryptographic algorithms before being transmitted to the blockchain network. Encryption ensures confidentiality so that individual voter choices remain private while still allowing verification.

### 4. Blockchain Integration and Smart Contracts

Blockchain technology is used to store votes as immutable transactions. Smart contracts automatically validate voter eligibility, confirm that a vote has not already been cast, and record the encrypted vote securely. Each block contains a timestamp and hash value, ensuring that any attempt to alter data can be easily detected.

### 5. Consensus and Validation Mechanism

A consensus mechanism is applied to verify transactions before adding them to the blockchain. Nodes in the network validate the integrity of the vote data and confirm authenticity. This decentralized validation process enhances security and eliminates reliance on a central server.

### 6. Result Calculation and Auditability

After the voting period ends, encrypted votes are securely counted through predefined smart contract

rules. The blockchain ledger allows authorized parties to audit the election process transparently without exposing individual voter identities. This improves accountability and builds public confidence in election outcomes.

**7. Security and Privacy Measures**

The methodology incorporates end-to-end encryption, hashing algorithms, and role-based access control to protect voter data. Privacy-preserving mechanisms ensure anonymity while maintaining traceability of transactions within the blockchain network.

Overall, this methodology integrates Aadhaar-based identity verification with blockchain's decentralized infrastructure to create an efficient, scalable, and secure digital voting system capable of supporting modern electoral requirements.

## VII SYSTEM MODEL

### SYSTEM ARCHITECTURE

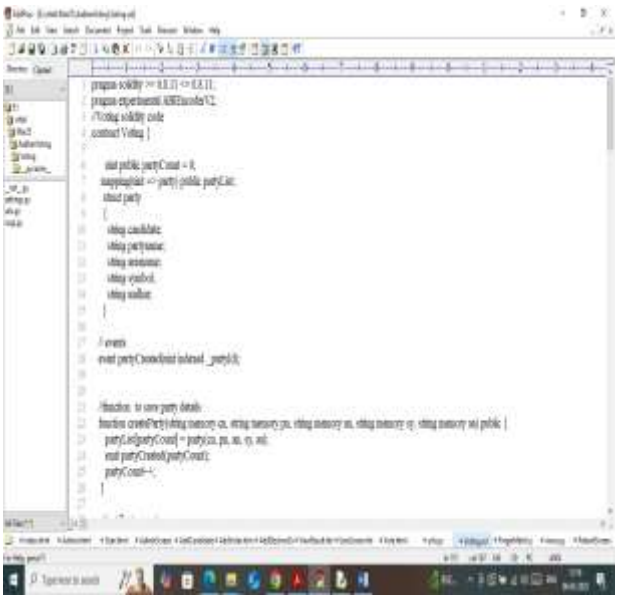
## VIII RESULTS AND DISCUSSIONS

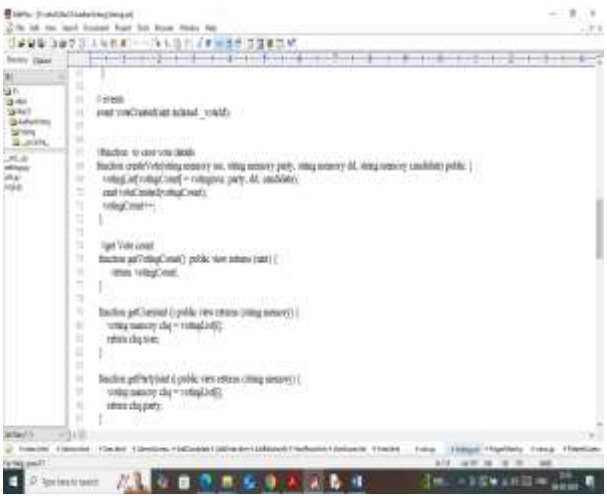
An Efficient Vote Casting System with Aadhar Verification through Blockchain

Traditional voting systems in India often fall prey to bogus voting and to combat against this bogus voting EVM has been deployed but EVM database can be easily tampered with. Blockchain has inbuilt support for secure (encrypted) and tamper-proof data storage, which can be utilized

Blockchain has inbuilt support for secured (encrypted) and tamper proof data storage which can be utilize to capture voter fingerprint and then matched with Aadhar fingerprint cloud database, if user fingerprint authenticated then only EVM will accept user vote. EVM will utilize IOT network to forward voting count details to centralized cloud server. IOT network cannot be easily hack so fully security will be provided to avoid any type of network attack.

Blockchain can store and retrieve data with the help of Smart Contracts which can be designed using Solidity programming. Smart contract contains functions which can be called with any programming language. To manage candidate and voter details we have designed following contract

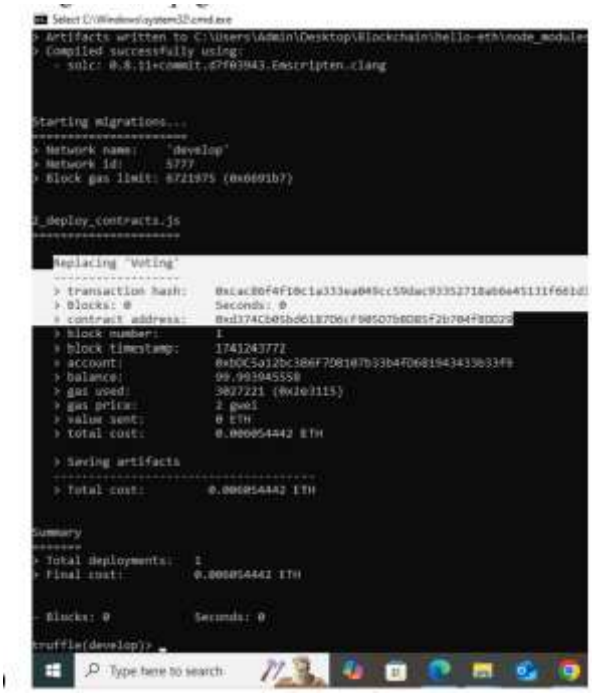




In above smart contract code we have defined required functions to manage candidate, voter and verification or tally functions. Now we need to deploy above contract to Blockchain Ethereum using below steps

1) First go inside 'hello-eth/node-modules/bin' folder and then look and double click on 'runBlockchain.bat' file to start Ethereum and get below page


2) In above screen Ethereum started with default accounts and private keys and now type command as 'migrate' and then press enter key to get below page




3) In above screen in white colour text can see 'Voting' contract deployed and running successfully. Let the above console running till you executed code. All candidates and voter data will be saved in above EVM Blockchain memory.

Modules Information

To implement this project we have designed two modules which consists of two different users such as 'Admin and Voter'.

1) Admin Login: admin can login to system using username and password as admin and admin
2) Candidate Registration: after login admin will add candidate details
3) Voter Registration: using this module admin will add voter details by taking finger and Aadhar details and this data will be saved in Cloud Blockchain server
4) Add Election Date: using this module admin will add election date
5) View Vote Count: using this module admin can view number of voted secured by each candidate

6) User Login: whenever voter comes to cast vote then EVM will display Login page along with fingerprint image to upload. EVM will tally/matched user finger with Cloud Aadhar finger database. Once fingerprint authenticated EVM will forward user to cast vote. Each user allowed to cast vote only one time
7) View Result: voter can view number of votes secured by each candidate
8) Latency Graph: using this module will plot Blockchain Latency graph which take time to verify voters.

SCREEN SHOTS

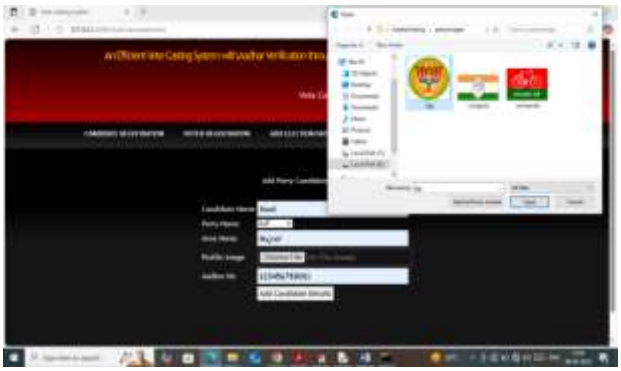
To run project double click on 'run.bat' file to get below page

In above screen python web server started and now open browser and enter URL as http://127.0.0.1:5000 and then press enter key to get below page

In above screen click on 'Admin Login' link to get below page

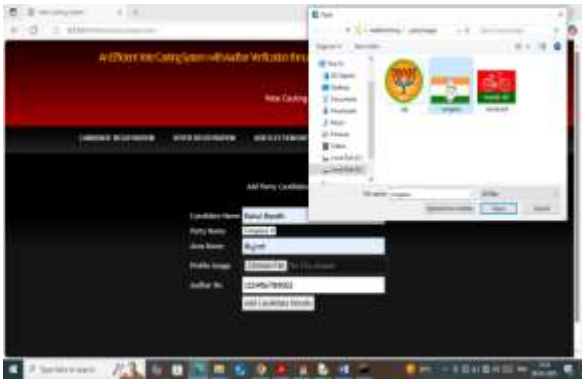
In above screen admin is login and after login will get below page

In above screen admin can click on 'Candidate Registration' link to add candidate details

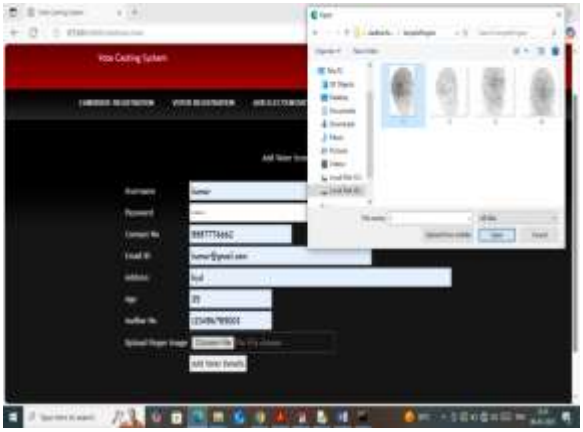


In above screen add candidate details along with party symbols and then press button to get below page

In above screen candidate details added to Blockchain and then in am displaying entire log obtained from Blockchain after data storage. In above log can see details like Transaction no, Block no, block hashcode and many other details. Similarly you can add as many candidates as you want



In above screen adding another candidate and now click on 'Voter Registration' link to get below page

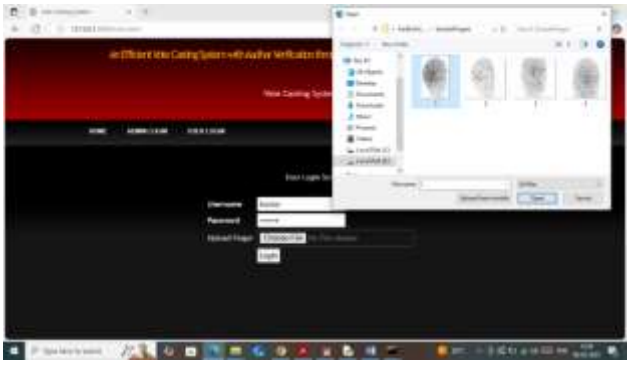


In above screen adding voter details along with Aadhar no and fingerprint and then press button to get below page. (Note we don't have Aadhar database or fingerprint scanner so we are uploading as image).

In above screen user details along with fingerprint added to Blockchain and similarly you can add as many voters as you want. Now click on 'Add Election Date' link to get below page

In above screen selecting and adding election date. You can choose any date but today only we have to run all modules so select today date only so voter can login and cast votes. Now click on 'View Vote Count' link to get below page

In above screen all candidates has 0 votes as no voter cast any votes yet. Now logout and login as voter to cast vote



In above screen voter is login along with fingerprint and then Blockchain will authenticate voter finger with cloud database finger and upon successful verification will get below page

In above screen in blue text can see voter successfully verified and now click on 'Cast Your Vote' link to get below page

In above screen Voter can see list of candidates and can click on 'Click Here' link to cast vote and then will get below page

In above screen in blue text can see Voter votes successfully casted to selected candidate. Now click on 'Latency Graph' link to get below page

In above graph x-axis represents number of Blockchain transaction an dy-axis represents latency to execute transaction. Now click on 'View Result' link to get below page

In above screen user can view which candidate got how many number of votes.

Similarly by following above screens you can run project and manage all voting details in Blockchain.

## IX CONCLUSION

The proposed efficient vote casting system with Aadhaar verification through blockchain presents a secure and transparent approach to modernizing digital elections. By integrating Aadhaar-based identity authentication with blockchain's decentralized and immutable architecture, the system effectively addresses major challenges such as voter fraud, data tampering, and lack of transparency in traditional and centralized e-voting platforms. The use of smart contracts automates eligibility verification and vote recording, reducing manual intervention and improving operational efficiency.

The implementation of encryption techniques and consensus mechanisms ensures voter privacy while maintaining the integrity and auditability of election data. Furthermore, the decentralized nature of blockchain enhances trust among stakeholders by providing a tamper-resistant and verifiable voting process. Although challenges such as scalability, regulatory considerations, and infrastructure readiness remain, the proposed framework demonstrates strong potential for building a reliable and secure digital election ecosystem.

Overall, this system contributes toward creating a transparent, efficient, and trustworthy voting environment that aligns with the growing demand for secure digital governance solutions in modern democratic societies.

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