

# COMPUTING SCIENCE

## **Removing Trusted Tallying Authorities**

Self-Enforcing E-Voting over Ethereum

**Authors:** *Patrick McCorry, Ehsan Toreini, Maryam Mehrnezhad*

**TECHNICAL REPORT SERIES**

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**No. CS-TR-1502**

**October 2016**

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We demonstrate that the Open Vote Network, a decentralised Internet voting protocol, can be run over Ethereum's blockchain today. Not only Ethereum can be used as a public bulletin board, but also it enforces the correct execution of the voting protocol. However, the Open Vote Network is only suitable for small-scale elections. For national elections, we present DRE-i and DRE-ip which both rely on a public bulletin board that can be realised using an Ethereum-like blockchain.

We improve trust in an election by removing trusted tallying authorities. While preserving the voter's privacy, our protocols allow anyone, including observers, to verify the integrity of the election without having to trust authorities. This follows a similar philosophy as seen in crypto-currencies such as Bitcoin which successfully removed the role of banks for maintaining a financial ledger.

## **Bibliographical details**

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### **About the authors**

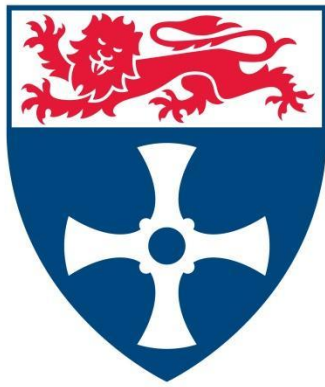
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### **Suggested keywords**

**Self-Enforcing E-Voting over Ethereum**



**Newcastle**  
University

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## Table of Contents

<b>1. Introduction</b>	3
Paper-based voting	3
Modern e-voting products	3
Academic research	3
Our vision	4
A practical public bulletin board	5
<b>2. Our Solution: Open Vote Network</b>	5
<b>3. The Proof-Of-Concept Implementation</b>	7
Implementation	7
Technicalities of the Ethereum platform	9
Cost analysis	10
<b>4. Scaling Up to National Elections</b>	11
<b>5. Meeting the Challenge's Criteria</b>	13
<b>6. Conclusion</b>	14
<b>Bibliography</b>	15
<b>Appendix</b>	17

*"I consider it completely unimportant who in the party will vote, or how; but what is extraordinarily important is this — who will count the votes, and how."*

*— Reported from Joseph Stalin [1]*

## 1. Introduction

### Paper-based voting

In paper-based voting, tallying is a critical process where the winner of an election is determined. When a voter inserts the completed ballot into the box, they lose sight of the ballot and have to trust election authorities to faithfully record and tally ballots. But corrupted authorities may modify, miscount or exclude the voter's ballot without the voter's knowledge. The lack of assurance on the tallying integrity is one major cause for disputes in the aftermath of an election.

### Modern e-voting products

In the modern digital era, e-voting products are being adopted by many countries to allow voters to cast ballots on a touch-screen direct-recording electronic (DRE) machine or over the Internet. Similar as before, voters have to trust election authorities to faithfully record and tally their electronic ballots. However, as compared with tampering with physical ballots, it is much easier for a single corrupted authority to tamper with the electronic records and tally.

### Academic research

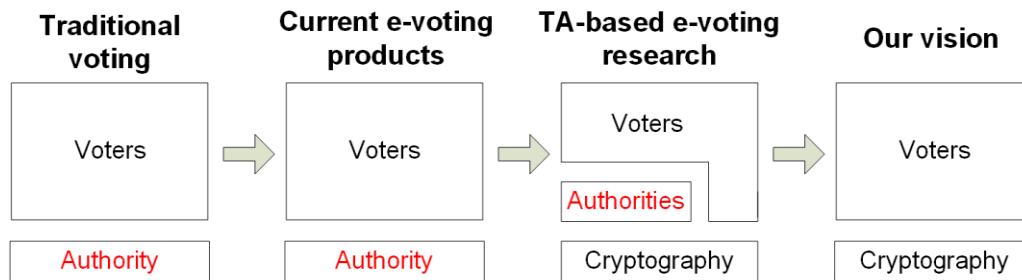
The state-of-the-art in the field of e-voting research concerns voting systems that are end-to-end (E2E) verifiable [2]. Being E2E verifiable means that voters are able to verify if their votes are cast as intended, recorded as cast and tallied as recorded. As the verification covers

from the start of casting a vote to the end of receiving the tally, this gives the name “End-to-End verifiable”.

To mimic the role of trusted counting staff in paper-based voting, almost all of the E2E voting systems assume tallying authorities (TAs), who are trustworthy individuals with computing and cryptographic expertise tasked to perform the tallying operation. However, voters must trust the TAs do not collude all together, as then they can learn each individual vote. The fact that TAs have such power presents a deterring effect on some voters when choosing their favoured candidates.

## Our vision

In our vision, we believe a future-generation e-voting system should be one that provides E2E verifiability *without* depending on any privileged group of people who act as tallying authorities. In other words, the system should be “**self-enforcing**”. This is highlighted in Figure 1.



**Figure 1: Evolution of the Trust on Tallying Authorities**

Our confidence in the feasibility of this vision builds on several existing “self-enforcing” e-voting protocols, namely Open Vote Network (**OV-net**) [3], Direct Recording Electronic with integrity (**DRE-i**) [5] and DRE-i with enhanced privacy (**DRE-ip**) [4]. OV-net is designed for small-scale boardroom voting, while DRE-i and DRE-ip are for national scale elections.

These protocols—in fact all verifiable e-voting protocols—require a public bulletin board where cryptographic data is published for public verification. The publication of data on the bulletin board must be append-only. If the previous audit data can be retrospectively modified, the assurance on the tallying integrity will be lost.

### **A practical public bulletin board**

In this challenge, we investigate Bitcoin [6] and its underlying public ledger, the blockchain, to identify if it can be used as a public bulletin board for electronic voting. Bitcoin’s blockchain is immutable and censorship resistant which are desirable properties for an e-voting public bulletin board. Unfortunately, it is only a global singleton database that can store data, and is limited in its support for programming capability, which is needed to enforce the execution of the voting protocol.

Among several existing blockchain systems, we choose Ethereum’s blockchain [7] for the proof-of-concept implementation of our e-voting solution. Conceptually, Ethereum is a global singleton computer that can store and execute programs (‘smart contracts’). The execution transcripts of these contracts are stored in the blockchain and verified by Ethereum’s underlying peer-to-peer (P2P) network. This decentralised P2P network enforces the correct execution of the programs without involving trusted third parties, hence the Ethereum blockchain is also considered “self-enforcing”.

In this report, we demonstrate a proof-of-concept implementation of OV-net [3], an efficient self-enforcing e-voting protocol, over Ethereum for the first time.

## **2. Our Solution: Open Vote Network**

Open Vote Network is a decentralized two-round voting scheme [3]. For a single candidate election with the Yes/No choice, this protocol can be described as follows (for the multiple



candidate version see [3]). First, all  $n$  voters agree on  $(G, g)$  where  $G$  is a cyclic group of prime order  $q$ , and  $g$  is a generator in  $G$ . Each voter  $P_i$  chooses a secret value  $x_i$  uniformly at random from  $[0, q - 1]$ .

**Round 1:** every voter  $P_i$  publishes  $g^{x_i}$  and a Schnorr Zero Knowledge Proof (ZKP) for proving the knowledge of  $x_i$ . At the end of this round, every voter validates all ZKPs, and computes:

$$g^{y_i} = \prod_{j < i} g^{x_j} / \prod_{j > i} g^{x_j}.$$

**Round 2:** every voter  $P_i$  publishes  $g^{x_i y_i} g^{v_i}$  and a one-out-of-two ZKP for proving that  $v_i$  is either 0 or 1 (for No and Yes respectively). At the end of this round, anyone who observes the protocol can tally the number of ones by computing:

$$\prod_i g^{x_i y_i} g^{v_i} = g^{\sum_i x_i y_i} g^{\sum_i v_i} = g^{\sum_i v_i}.$$

The above protocol works based on the cancellation of random factors at the tallying phase i.e.,  $\sum_i x_i y_i = 0$  where by the definition  $y_i = \sum_{j < i} x_j - \sum_{j > i} x_j$  (see Round 1). As an example, assume  $n = 4$ , the random factors will be cancelled as shown in Figure 2. From  $g^{\sum_i v_i}$ , anyone can compute the tally  $\sum_i v_i$  by exhaustive search.

**Example**

Assume  $n = 4$ .

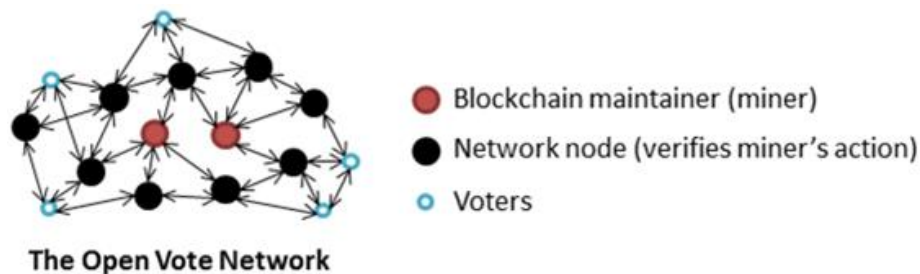
$$\begin{aligned}
 \sum_i x_i y_i = & \quad -x_1 x_2 - x_1 x_3 - x_1 x_4 \\
 & + x_2 x_1 \quad - x_2 x_3 - x_2 x_4 \\
 & + x_3 x_1 + x_3 x_2 \quad - x_3 x_4 \\
 & + x_4 x_1 + x_4 x_2 + x_4 x_3 \quad = 0.
 \end{aligned}$$

**Figure 2: An example of random factor cancellation**

This scheme assumes an authenticated public channel available for every voter. Using a public bulletin board is commonly suggested to realize such a channel. However, in practice, implementing such a secure bulletin board has remained a technical challenge. We believe the blockchain holds the key to this problem and will demonstrate the feasibility by presenting a concrete proof-of-concept implementation.

### 3. The Proof-Of-Concept Implementation

In our implementation, voters need to connect to Ethereum's underlying peer-to-peer (P2P) network as shown in Figure 3, and their identities are represented by Ethereum accounts. These accounts are simply public-private key pairs that have been locally generated on the voters' machines, and should have a positive balance of ether (Ethereum's currency). The voter can compute a digital signature using their Ethereum account to prove the authenticity of data that they send during the voting process.

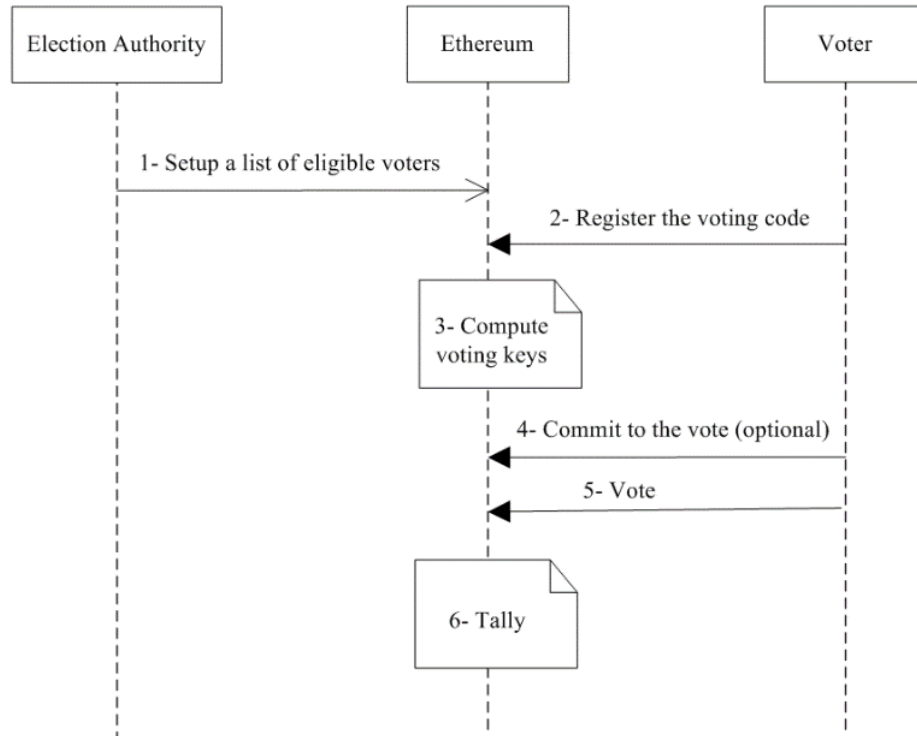


**Figure 3: How voters connect to Ethereum's underlying peer to peer network**

#### Implementation

Our proof-of-concept implementation is written in Ethereum's solidity language [8]. We have implemented the system's user interface using HTML5 and JavaScript where it has three different views: voter page, Election Authority page, and a live feed page (see Figures 7-10 in Appendix for screenshot examples). These interfaces are designed to ease the interaction

between the voters, Election Authority and the Ethereum network while enabling them to observe the voting procedure.



**Figure 4: The Sequence diagram of our implementation**

The steps of the system are explained in Figure 4.

- **SETUP.** The Election Authority establishes the list of eligible voters and informs Ethereum to transit to the signup phase. In addition to the election question, and in order to assure the voters that the election will happen in a timely manner, a list of start and end times for each phase is sent to the network too.
- **Register.** The voter participates in the first round of OV-net by registering their ballots for the election. We have implemented Schnorr ZKP based on [9]. The registration ballot is accepted by the network once the ZKP is verified successfully. When the registration deadline is past, the Election Authority informs Ethereum to finish the registration phase.
- **COMPUTE.** Ethereum computes each voter's voting key (i.e.,  $g^{y_i}$ ). Each voter can retrieve their voting key from Ethereum before casting their vote.

- **COMMIT (Optional).** The voter can send a 'commitment' of their encrypted vote to the Ethereum network. The commitment is a one-way hash of the round-2 message. Without this phase, in the second round of the protocol the final voter may privately compute the tally before sending their vote and this might influence the candidate they choose. Sending a 'commitment' is the equivalent to posting the vote in a sealed envelope to the network, and only revealing the votes once all sealed envelopes have arrived.
- **VOTE.** The voter participates in the second round of OV-net by sending an encrypted vote and a one-out-of-two ZKP which we have implemented based on [19]. The vote is accepted into the blockchain only if the ZKP is verified successfully.
- **TALLY.** The tally is computed by the Ethereum network using the tally computation method defined in OV-net.

## Technicalities of the Ethereum platform

During the implementation, we encountered several technical difficulties.

**First**, Ethereum only supports 256-bit unsigned integers. For this reason, we chose to implement the protocol over an elliptic curve instead of a finite field. Unfortunately, Elliptic Curve cryptography is not natively supported yet and this required us to find an external library to perform the computation. This library must be stored in the blockchain alongside our program, which led to our initial voting contract being too large to store on the network. To resolve this issue, we had to separate our program into two smart contracts: one 'voting contract' for computing votes and verifying ZKPs and the other 'cryptography contract' for creating ZKPs (see Figure 12 in the Appendix). Note that any computation performed on Ethereum requires 'gas' which can be purchased using 'ether'. Each block has a gas limit that corresponds to the maximum amount of computation allowed.

**Second**, the call stack of a program has a hard-coded limit of 1024 stack frames [10]. This limits the amount of local memory available, and the number of function calls allowed. These limitations led to difficulty while implementing the 1-out-of-2 ZKP as the temporary

variables typically required exceeded the hard-coded limit. We had to use variables extremely sparingly to make the program work.

**Third**, there exist few debugging tools for these smart contracts. The best practice is to create an ‘Event’ that logs data along with the contract. These events need to be incorporated into the program before compiling the contract, and they do not allow running the code step by step.

**Finally**, the random numbers used for the ballot and casting the vote need to be stored on the voter's local machine. This is important to ensure that if the voter's web browser crashes or is accidentally closed, then the random number is not lost. To this end, we built a standalone Java program that generates the random numbers on the voter's local machine, and the voter is requested to upload those numbers as ‘voting code’ into the voting page.

## Cost analysis

Our prototype of OV-net was tested using Ethereum's official test network [7] with 40 voters to assess the cost of running an election. The voting and cryptography contracts cost £0.78 and £0.50 respectively to store on the blockchain, and 125 Ethereum transactions (see Figure 11 in the Appendix) to run the election with a total cost of £27.72. As shown in Figure 5, the average cost is £0.69 per voter, which is lower than the typical cost of running a paper-based election (see Appendix: Table 3 for a detailed breakdown of cost and Table 4 for comparisons with the reported costs in real-world elections). The most expensive operations include the voter registering their ballot (£0.14, i.e., 15% of a block's available gas) and casting their vote (£0.49, i.e., 53% of a block's available gas). This suggests that within one block (generated approximately every 12 seconds) only six voters can register for the election, and only one vote can be cast per block using the current Ethereum network.

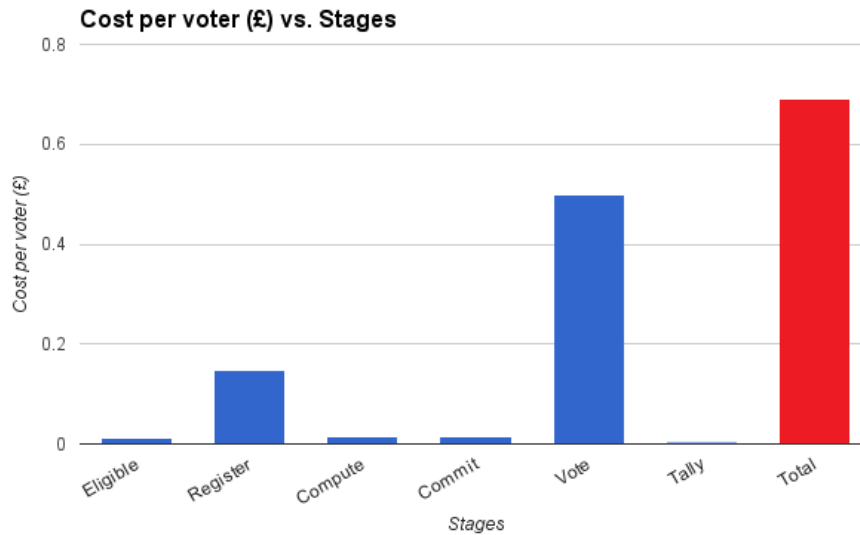


Figure 5: The cost of voting using our system

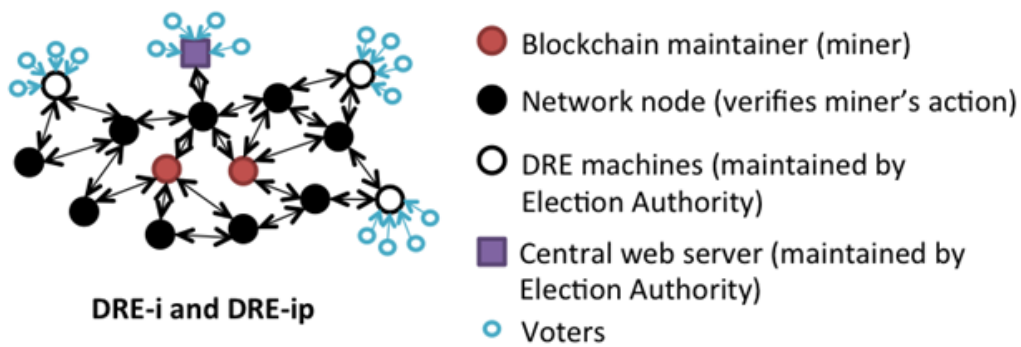
## 4. Scaling Up to National Elections

Scaling up our solution to national elections requires addressing limitations in both Ethereum's blockchain and the e-voting protocol.

**First**, using Ethereum as deployed today, only one vote can be cast in one block. Given that each block is generated every 12 seconds, this means only five votes per minute can be cast over the blockchain. Take the 2011 UK Referendum an example. For 5.2 million votes (the number of postal votes in that election), it would require 722 days for all votes to be recorded into Ethereum's blockchain.

To support national scale elections, a dedicated Ethereum-like blockchain will be required. Such a blockchain will provide a consistent global database that all voters have access to and guarantee that all inserted data remain immutable. Election audit data sent to the blockchain will be verified by independent validators who act as 'miners' and get awarded for verifying the audit data and maintaining the blockchain. Each block should allow storing more votes by increasing the gas limit and new blocks may be generated at a faster speed than the current 12 seconds per block.

**Second**, another limitation concerns the e-voting protocol. OV-net is decentralized and is designed only for small-scale boardroom voting [3]. To support national-scale elections, we propose using DRE-i [5] and DRE-ip [4], which follow a similar “self-enforcing” idea as the Open Vote Network but use a centralised voting facility (either a web server or a DRE machine) to directly record votes from the voter (without knowing the voter’s real identity, which can be ensured through physical or procedural means [4,5]). For both DRE-i and DRE-ip the centralised facilities need to connect to the Ethereum network, as shown in Figure 6.



**Figure 6: How DRE-i and DRE-ip connect to the Ethereum network**

Due to the space limit, we only briefly describe DRE-i [5] and DRE-ip [4]. Both protocols are E2E verifiable voting protocols designed for supporting large-scale elections without tallying authorities. The difference between the two is that DRE-i pre-computes the encrypted ballots before the election while DRE-ip computes the encrypted ballots in real time during voting. The pre-computation has the advantage of minimizing the latency in voting, which makes **DRE-i a suitable choice for Internet voting** since the server must be able to handle many simultaneous vote submissions. By contrast, DRE-ip does not perform pre-computation and hence removes the need to securely store the pre-computed ballots. The protocol provides strong guarantee on the vote privacy in the sense that when the DRE machine is completely compromised, the information leakage is minimal as only the partial tally is revealed. These properties make **DRE-ip a suitable choice for polling station voting**.

## 5. Meeting the Challenge's Criteria

As summarized in Table 1, OV-net satisfies four out of the five criteria set by Kaspersky. The only exception is that it does not prevent voting under duress. This is because voting happens in an **unsupervised environment** and the voter is not guaranteed a private moment to cast their vote. This can be addressed by implementing e-voting under a **supervised environment** at polling stations using DRE-ip; a private moment of voting is assured by the use of a private voting booth. OV-net provides the maximum protection on voter privacy as only a full-collusion that involves all other voters can reveal the vote [3]. The tallying process guarantees that all votes stored on Ethereum's blockchain are included in the final tally, which everyone can compute. The tally is only computable when the final vote has been cast, which effectively hides interim results. Finally, the protocol allows easily adding an 'abstain' option as an additional candidate choice for undecided voters.

**Table 1: Open Vote Network vs. challenge's criteria**

<b>Criteria</b>	<b>The Open Vote Network</b>
Voter privacy and the ability to count votes	All voters must collude to reveal an individual vote, and the system is self-tallying without needing any trusted tallying authorities.
Problem of voting under duress	Voter has no private moment, and coercion is possible.
Availability of interim results	No interim results available; tally computable only when the last vote is cast.
Undecided Voters	Voter has the option to register for election; empty votes cannot be casted; cast votes cannot be modified and voters can select 'abstain'.
The voting aftermath	Dispute-free; all election data is publicly verifiable.

In our analysis, we identify three different voting settings: **decentralized Internet voting**, **centralized Internet voting** and **centralized polling station voting**. Accordingly, we present a solution for each of these settings. Our three solutions cover all election scenarios that we



know of today. All our solutions allow voters to verify the tallying integrity without having to trust TAs, while the blockchain self-enforces the execution of the voting protocol. As compared with existing voting methods in real-world elections, our solutions provide compelling benefits in terms of voter verifiability and assurance on the tallying integrity, as summarized in Table 2.

**Table 2: Summary of comparison on verifiability and tallying integrity**

	Decentralized remote voting	Centralized remote voting		Centralized polling station voting			
Schemes	<b>Open Vote network</b>	<b>DRE-i</b>	Postal	<b>DRE-ip</b>	Paper	DRE	DRE with paper audit trail
Voter can verify if vote is cast as intended	✓	✓	✓	✓	✓	✗	✓
Voter can verify if the cast vote is recorded	✓	✓	✗	✓	✗	✗	✗
Voter can verify if votes are tallied as recorded	✓	✓	✗	✓	✗	✗	✗
Assurance on tallying integrity when TAs are all corrupted	✓	✓	✗	✓	✗	✗	✗
Suitable election	<b>Small-scale</b>	<b>Large-scale</b>	Large-scale	<b>Large-scale</b>	Large-scale	Large-scale	Large-scale

## 6. Conclusion

The Economist and Kaspersky challenged us to build secure digital voting using the blockchain. We found motivation from the realm of cryptocurrencies that has so far successfully removed the need to trust a central bank or institution to maintain a financial ledger. In this challenge, we proposed to remove trusted tallying authority from the election process. To accomplish this goal, we built a prototype of the Open Vote Network protocol and demonstrate that it is a practical solution that works on Ethereum today. The role of

Ethereum is not limited to a simple public bulletin board, but also to enforce the correct execution of the voting protocol.

Two further protocols DRE-i and DRE-ip are described to demonstrate that our approach can scale up to a national election. Most importantly, all solutions are fully verifiable and provide a strong guarantee on the integrity of the tallying results – and by doing so, preserving the integrity of democracy.

## Acknowledgement

This work is supported by the ERC Starting Grant (No. 306994).

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## Appendix

The screenshot shows a web interface for a voting system. At the top, a progress bar with seven steps is visible: 1. VOTING CODES, 2. UNLOCK ADDRESS (highlighted in green), 3. REGISTER, 4. COMPUTE, 5. COMMIT, 6. CAST, and 7. TALLY. The main content area is a white box with a dark border. It contains the following elements:

- Address:** A text input field containing the hexadecimal address `0x4d1df6f5cce07686db89bc5e5a9b9767d63fa37a`.
- Password:** A text input field with masked characters (dots).
- Login:** A green button.
- Only eligible addresses appear in the list**: A message below the login button.

Figure 7: Voter page, Login to the Ethereum

The screenshot shows a web interface for a voting system. At the top, a progress bar with seven steps is visible: 1. VOTING CODES, 2. UNLOCK ADDRESS, 3. REGISTER, 4. COMPUTE, 5. COMMIT, 6. CAST, and 7. TALLY (highlighted in green). The main content area is a white box with a dark border. It contains the following elements:

- Tally**: A heading.
- Should Satoshi Nakamoto reveal his real identity?**: A question.
- Yes: 34 No: 6**: The results of the vote.

Figure 8: Voter Page, The election results

The screenshot shows a web interface for an election authority. It contains the following elements:

- Who is eligible to vote?**: A heading.
- There are currently 40 eligible voters.**: A message.
- Eligible voters list:** A text area containing a list of 40 hexadecimal addresses, including `0x4d1df6f5cce07686db89bc5e5a9b9767d63fa37a`, `0x78d4231f78ef3079bb84e886d180d0a0005d2f71`, `0xbab0d37267fc972b1408a0e61472cd8dcb8d0cd8`, and `0x8f46475b71d5e2c0be2f673`.
- Update eligibility list**: A button.
- Next**: A blue button.

Figure 9: Election Authority page: Setting up the list of eligible voters

## TALLY: Yes - 2 No - 1

Colour codes.
Voter has voted.
Optional Phase: Voter has committed (and not revealed) their vote.
Voter has registered to vote.
Voter is eligible to vote.


Vote Cast.
0x60087645e15abb4292fb4fd69f21245a9d1967d1
0xbab0d37267fc972b1408a0e61472cd8dcb8d0cd8
0x78d4231f78ef3079bb84e886d180d0a0005d2f71

Committed (and not revealed) their vote.
0x78d4231f78ef3079bb84e886d180d0a0005d2f71
0x60087645e15abb4292fb4fd69f21245a9d1967d1
0xbab0d37267fc972b1408a0e61472cd8dcb8d0cd8

Registered to vote.
0x60087645e15abb4292fb4fd69f21245a9d1967d1
0xbab0d37267fc972b1408a0e61472cd8dcb8d0cd8
0x78d4231f78ef3079bb84e886d180d0a0005d2f71


Eligible to vote.
0x78d4231f78ef3079bb84e886d180d0a0005d2f71

Figure 10: The Live Feed page showing voting in progress


MORDEN TESTNET

GO
LANGUAGE

[HOME](#)
[BLOCKCHAIN](#)
[ACCOUNT](#)
[TOKEN](#)
[MISC](#)



**Contract Address** 0xA1bB838dc6a4b5e96405B1E44F38c57AC39F5249
 Home / Contract Accounts / Address

**Contract Overview**


ETH Balance: 0 Ether

Mined: 0


No Of Transactions: 126 txns


**Misc**

Contract Creator 0x9393a1882a871be... at txn 0xe91075e4248c61b...

QR CODE 

**Transactions**
Contract Code

 Latest 25 txns from a total Of 126 transactions

TxHash	Block	Age	From	To	Value	(Tx Fee)
0x3302f13af57270f9...	1707291	40 mins ago	0x9393a1882a871be...	IN	0x1bb838dc6a4b5e...	0 Ether 0.01481339
0xcadfbdb88015d0...	1707290	41 mins ago	0x8e8a1767359c820...	IN	0x1bb838dc6a4b5e...	0 Ether 0.04995558
0x1b43cf23023f078a...	1707288	43 mins ago	0xea611b0db3df3f58...	IN	0x1bb838dc6a4b5e...	0 Ether 0.0500888
0xb7889c581d67af8...	1707287	43 mins ago	0x49c318b633cda98...	IN	0x1bb838dc6a4b5e...	0 Ether 0.0497967
0xd604faae640ca41f...	1707286	43 mins ago	0x46e5d8d0a2013b...	IN	0x1bb838dc6a4b5e...	0 Ether 0.04995278
0xc0e88265e16eaf1...	1707285	44 mins ago	0x5e016a8e026c835...	IN	0x1bb838dc6a4b5e...	0 Ether 0.0498973
0xe84c8568ef138ec...	1707284	44 mins ago	0x85da51a8b31976f...	IN	0x1bb838dc6a4b5e...	0 Ether 0.0498388
0x655b2014dbb0e46...	1707283	44 mins ago	0x9924faeb61449fcd...	IN	0x1bb838dc6a4b5e...	0 Ether 0.05022742
0xb7ab0ea4528a8ffc...	1707282	45 mins ago	0xf13c7bf8779ea423...	IN	0x1bb838dc6a4b5e...	0 Ether 0.04982942
0x189142547f3529e...	1707281	45 mins ago	0x884c3b4d9ee0c96...	IN	0x1bb838dc6a4b5e...	0 Ether 0.04995774
0x00b72dd3f576613...	1707280	46 mins ago	0x2e64af52354603f6...	IN	0x1bb838dc6a4b5e...	0 Ether 0.0493812
0x5894fbd0a786f81...	1707279	46 mins ago	0xf9267ea46dd4d02...	IN	0x1bb838dc6a4b5e...	0 Ether 0.05029458
0xbf7b4a4533cc5d8...	1707278	46 mins ago	0x920173beb92421b...	IN	0x1bb838dc6a4b5e...	0 Ether 0.05046496
0x87ccd23f0afcded...	1707277	46 mins ago	0x9cd81fe98217312...	IN	0x1bb838dc6a4b5e...	0 Ether 0.05011624

Tally transaction

Vote transactions

Figure 11: The transaction page of a sample election over Ethereum (<https://testnet.etherscan.io/address/0xa1bb838dc6a4b5e96405b1e44f38c57ac39f5249>)

VMTrace

- The cost of the voting contract

**Table 4: Comparison of cost with existing voting systems**

Location	Type of Election	Cost per Registered Voter	Election Title/Year
<b>UK Wide [11]</b>	Paper Based	£3.01	UK Referendum/2011
<b>California [12]</b>	Paper/DRE with paper trail[17]	\$2.77	General Election/2014
<b>Colorado [13]</b>	Mail[17]	\$6.04	General Election/2014
<b>North Dakota [14]</b>	Paper Based[17]	\$4.30	General Election/2014
<b>Wisconsin [15]</b>	Paper/DRE with paper trail[17]	\$19.10 (\$3.19 if all registrants showed up)	General Election/2014
<b>India [16]</b>	Electronic Voting Machines (EMVs) [18]	17 INR (about \$0.25)	General Election/2009
<b>Open Vote Network</b>	Decentralized internet voting	£0.67	Trial election over Ethereum/2016