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Online Voting System Using Blockchain

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Abstract: *Blockchain technology has been presented as a support for trust needs between transactions in electronic information systems. Its successful use in cryptocurrencies has allowed it to explore its capabilities in commercial, industrial, and service systems, backed by the operational alternatives offered by Ethereum Smart Contracts and the cryptographic security of public and private key. These keys are used as a way to make online transactions anonymously, with the guarantee offered by the Blockchain network that they are executed safely. With the above in mind, this concept can be extended to the electoral processes, thus allowing its application in electronic voting systems, especially when the protocols currently used lack the trust factor between the different social actors. This document presents a proof of concept in which Blockchain and other technologies are applied, to allow interaction as an electronic voting system for the election of unique candidates. This has been achieved through the specification of an architecture designed especially for electoral processes, from which it is implemented and a simulation is carried out in order to obtain data that generates value, when evaluating Blockchain technology as an alternative to current voting systems.*

Keywords: Blockchain, Cryptography, Electronic Voting, Proof of Concept, Smart Contracts

I. INTRODUCTION

The exercise of conducting elections through a voting process, either using voting systems conventional (physical voting cards) or electronic voting systems style it has become an event of greater social relevance, in addition to being the direct route in which the citizens or members of an organization connect and manifest themselves with those who govern them. This exercise is the source and support of the government and the governed, giving a certain sense of political stability in a nation or the different administrative structures that, through democracy, elect their representatives.

Various ways have been proposed to vote, ranging from emails, encrypted digital ballots, voting devices, secure FTP connections, cards, certification authorities, using otp now Blockchain, among others. The traditional voting methodologies used have, however, resulted in different results.

In social sectors, the electoral results are discussed with arguments ranging from the manipulation of the registration of voters (impersonation, voting of unauthorized persons), inaccurate voter counting, security fragility of existing systems, to the impossibility of carrying out an exhaustive audit of the voting system, to generate the necessary confidence that these processes must have [1].

This document presents approve for electronic voting supported by Blockchain technology, which aims to largely meet the needs expressed by social actors, combining cryptographic procedures and the programming of agreements between the parties through smart contracts.These methods seek to ensure compliance with the "principles of universal voting", such as: anonymity, in-´ability to link a voter with the vote, impartiality such as the inability to know partial results until the end of the vote, verifiability as the ability to verify the transaction made, reliability and integrity is known as the inability to eliminate or change votes, and security is understood as protection against denial of service attacks or denial of information [2]. This article is organized as follows. Section II presents the context of the on-voting scenario used in the architectural test. Section III talks about the approach to the problem. Section IV describes the architectural test implemented. Section V presents the results obtained as a discussion on the applicability of the technique in the proposed electoral context.

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II. LITERATURE SURVEY

Currently increasing digital technology helped many people lives. In contrast to the electoral system, there are many conventional uses of paper in its implementation. The aspect of security and transparency is a threat from still widespread election with the conventional system. Block chain technology is one of solutions, because it embraces a decentralized system and the entire database are owned by many users. There is no doubt that the revolutionary concept of the blockchain, which is the underlying technology behind the famous crypto currency Bit coin and its successors, is triggering the start of a new era in the Internet and the online services. In this work, we have implemented and tested a sample e-voting application as a smart contract for the Ethereum network using the Ethereum wallets and the Solidity language. Block chain was first introduced by Satoshi Nakamoto (a pseudonym), who proposed a peer to-peer payment system that allows cash transactions through the Internet without relying on trust or the need for a financial institution. Block chain is secure by design, and an example of a system with a high byzantine failure tolerance. E-voting is a potential solution to the lack of interest in voting amongst the young tech savvy population. For e-voting to become more open, transparent, and independently auditable, a potential solution would be base it on block chain technology. Block chain technology has a lot of promise; however, in its current state it might not reach its full potential. Electronic voting has been used in varying forms since 1970s with fundamental benefits over paper based systems such as increased efficiency and reduced errors. With the extraordinary growth in the use of block chain technologies, a number of initiatives have been made to explore the feasibility of using block chain to aid an effective solution to e-voting. It presented one such effort which leverages benefits of block chain such as cryptographic foundations and transparency to achieve an effective solution to e-voting. The proposed approach has been implemented with Multichain and in-depth evaluation of approach highlights its effectiveness with respect to achieving fundamental requirements for an e-voting scheme.

III. CONTEXTO

This proof of concept was approached with the purpose of knowing the universal principles of voting systems, and especially those of trust worthiness and integrity, so this section presents the main concepts of voting systems, and the technologies used in the Blockchain.

3.1 Consultation of Opinion

An opinion consultation is a process by which the different academic directors of the University can be chosen. This process allows administrative staff, teachers, and students to give their vote to a candidate, in this particular case, a candidate who aspires to the position of Rector of the University of Quint. When a voter wishes to vote, he looks for his name in the paper lists that the University has to know his place and voting table within the University Campus, later he approaches the table, identifies himself with an identity document, to receive a card with which he arrives at a cubicle where he can exercise his vote anonymously. Finally your vote is cast in a ballot box.

3.2 Electronic Voting

It is the most advanced system within the systems of electronic democracy, since it is 100% digital, from the authentication of the citizen to the emission on of the suffrage [3]. There are 2 types of voter electronic [1], the first occurs when the voter is present at his polling station on and the second when it is carried out using the internet in any location.'' For this work, it is based on the presumption that 'the electoral process is based on the use of voting stations located long in a voting station, which will be from where the citizen will cast to a vote in favour of the candidate of his preference. Forms of electronic voting range from the use of perforated cards, optical scanning systems and Direct Recording Electronic Voting (DRE) systems to internet ballots and telephone votes [4]. However, they all have something in common, the different principles that must be taken into account for a vote to be done satisfactorily. According to [5] the following must be taken into account:

Previous Works

The work [6] proposes a system that allows an electoral process, where voters can issue tokens from their wallet, to a candidate; prior validation of your identity by the administrators. In addition, they use a proof of 'with zero record to

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validate the ballot issued.´In [7] they propose to use IoT to authenticate the voter and subsequently send their vote to the blockchain, which is where it finally remains stored. Once the election day is over, the vote count begins and the winner is cast. In [7] it is stated that this is achieved at a lower cost compared to traditional paper voting. Every time blockchain technology attracts more attention to be used in electronic voting, and this can be seen in [8], which analyses 15 works of different approaches in favour of electronic voting. Most agree that Ethereum is a promising technology for this type of event, and they use it in various ways. To make a comparison of these works, the authors rely on the following parameters such as: authentication, platform, anonymity, verification of the voter, decentralized and technology used [8]. There are countries that have implemented this system, among them are: Belgium, Brazil, the United States, Estonia, the Philippines, India, and Venezuela [2]. Some are in the process of being implemented on´and others avoid it, such as Germany, Holland, Finland, Ireland, Kazakhstan, Norway, and the United Kingdom [2]. In [9] they show a video system called Source - available for universities using Ethereum and its Smart Contracts, which allows them to manage voters and vote traceability. Of the countries mentioned, Estonia decided to implement electronic voting through a system called I-Voting, which allows all its inhabitants to vote from any corner of the world and changing the choice of candidate if the voter wishes, where the last candidate who has been selected, will be the one who is counted his vote [10]. I-Voting was received with scepticism, now enjoys great popularity and is increasingly increasing, reaching an average Internet voting time in 2015 of 2 minutes and 36 seconds, which was calculated bearing in mind that the election day lasts a whole week (from February 21 to 27) [10]. Bolivia is one of the many countries that continue to carry out votes in the traditional way with physical cards, voting stations in a specific place, juries and voters; having the same problems as other countries: electoral fraud, human errors in the processes, violation of computer attacks,´ centralized electoral process by autonomous entities, among others [11]. In [11] an electronic voting proposal is made for Bolivia using a wallet and coins as an asset to vote, so the voter sends a coin to the candidate of his preference as a form of voting [11]. Faced with the viability or not of this technology, we continue to investigate and propose ideas, among which are: certifying entities, digitally signed votes to verify their origin, secure FTP (File Transfer Protocol) sessions, encryption algorithms symmetric a, among others.´´

Blockchain

This technology is used to construct specific types of distributed databases composed of immutable blocks of data, each with a list of transactions and a unique reference to its predecessor block. Blockchain technology is the subject of intense and growing attention among governments [12]. To be able to make references to previous blocks, mathematical relations of hashes are used, being 'the database protected cryptographically and managed' by a global network of computers, where the information can not be altered [13]. The Blockchain network saw the light in 2008 in an "organic" way and in 2009 one was implemented for Bitcoin. The theory of it was made known by the pseudonym Satoshi Nakamoto through the Whitepaper reported [12]. Within a Blockchain, everything is a node. A node refers to a person who, through a computer, with a local copy of the network and special software to mine, becomes part of the network. This person is in charge of making minor of blocks, ensuring the integrity and transparency of the network, by participating in a mechanism called consensus. All updates of the status of the Blockchain are made through transactions, using public and private key cryptography. These transactions generate a cost measured in gas, which is a measure of the computational expenditure by the miners to be able to write to the network. The amount of gas used in a transaction determines the reward for the miners.

3.3 Ethereum

Developed by “Vitalik Buterin” Ethereum is an open Blockchain platform that allows anyone to create and use Decentralized Applications that run on Blockchain technology [14]. The code in Ethereum is executed inside a virtual machine called the Ethereum Virtual Machine (EVM). This can execute arbitrary algorithmic complexity code, so developers can create decentralized applications that work in the EVM, this is done using well-known programming languages, such as JavaScript and Python [14]. The contracts are programmed in Solidity the most popular language. 'These are a collection of states and functions, similar to a kind of Object-Oriented Programming [15]. When contracts are deployed, they are assigned an address to call the different functions public own, which represent the business logic in a “ Decentralised App ”. An address (key), is a sequence of characters that´ represents an account within the

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Blockchain, using cryptography based on the Digital Signature Algorithm of Curve Elliptic (ECDSA), a public key is generated and a´ private, where the first can be known by anyone, the private one is for personal use to manage assets or Tokens. The public address is obtained from the private on address ,´and the opposite process cannot be carried out. A token is a representation of a financial security a digital asset that can be used by different users of the network, to exchange it through transactions.

Used Technologies

The proof of concept used the following:

- Ganache: which simulates a private Blockchain familiar to the main Ethereum network that is public.
- Meta mask a plugin that allows a browser to work with these decentralized technologies.
- Truffle: a development suite for smart contracts, which has a debugger, compiler, and commands to deploy Smart Contracts.
- ReactJS and JavaScript: library and programming language respectively, used for the Front End.
- Web3JS: a library through which you can connect the Front End with the Smart Contracts stored in the Blockchain and call their functions.

The Ethereum Blockchain is chosen, since it allows the programming of smart contracts for the logic of´ business, allowing the creation of customizable tokens,´ in addition, it is considered that it is a Blockchain establish, which´ has a great reception for its flexibility, and it is expected to have support for a long time. The Bitcoin network is discarded given its high transparency approach that can be detrimental to anonymity, falling into the drawbacks that are described in the next section. In addition, you have no control over it. Cardan is discarded because the introduction of smart contracts is recent and may contain errors, the same happens with other blockchains.

IV. PLAN TO IMPLEMENTATION

The traditional form of voting using cards, as a participation mechanism, receives harsh criticism for the lack of transparency and its high complexity to audit the votes cast. Added to this, the distrust of voters, given the guarantees of integrity, reliability and anonymity, is increasing, since the system lends itself to the counting of votes in favour of a candidate, through the third parties that interact in the count. In addition, some conflicting proposals, as described in the next section, address mostly some of these principles, leaving aside others. By which, a solution is necessary to meet these needs.

V. SOLUTION

Unlike other proposals, the present one eliminates the need for third parties (such as certifying authorities), also the possible cooperation of voters, and the exposing of a public key linked to the vote when the transaction is carried out ; inconveniences that in most of the literature do not deepen. The proposal is based on the ERC-´20 standard (Request for Comments from Ethereum). This allows you to create tokens and, in this particular case, use them as a vote. It should be clarified that the behaviour of the token functions has been subtly modified in order to adapt it to the project; in particular, the way in which the balance sheets of the candidates' accounts are consulted, in order to meet the criterion of impartiality. The authors in [16] propose a similar form of voting but using coins, where each voter is assigned one and can send it to the wallet of the candidate as support, from any place and device that supports the technologies analysis This method is easy and fast, however, there is a risk of finding the identity of the voter, since the voter uses his public key to "vote what registered in the transaction, and in turn, will be "found" linked to the candidate's wallet; therefore, anyone who knows that key can know by whom that person has voted. Another drawback is the coercion to 'reveal your public key, and as, search through the transactions of the blockchain until you find the transaction of the vote. Finally, another point to highlight is the additional work given to the voter, since he must remember the private address to be able to vote, and, if he loses it, he will not be able to do so. In this proposal that is presented, only the address on of the table and the candidate are used to make transfers of tokens instead of coins, which overcomes the previous drawbacks of automatic, by not having an address on which to relate the voter with his vote. To start, as many tokens as potential voters are enabled are created, and a "certain amount of these is transferred to the tables, based on the number" of voters who have been assigned to it using paper lists. This is done in order for each table to be the one

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who authenticates and authorizes its constituents to spend tokens that were transferred to it; therefore, the voter is free to spend (cast) a single token (vote) on behalf of the table, so he can transfer it to the candidate's account as a symbol of support (vote). As a consequence, the traceability of the data can be carried out, since the granularity is simple, and also allows the anonymity of the voter, since it is only linked to the table with the vote cast and the receiving candidate.

5.1 Design Architecture

Within the design, 2 architectural patterns were used , the one used by the Blockchain network and the Model View - View Model (MVVM) pattern. The first pattern will be to the model (Model) of the second to store data from the D app. The view (View) is given by the user interfaces used to present the information to the user, and the View Model corresponds to the 'contracts', where the entire business logic will be programmed.' In order to know how the different components of the system that is being developed are related, a diagram of components is presented to see the different interrelations, as can be seen in Figure 1. This is most easily explained using Figure 2, which is an abstraction of Figure 1. Both figures show how the flow of the 'data' is worked, bearing in mind where it originates, through the 'actions of a user, and where it ends up stored, which is in the Ethereum Blockchain. Now that the data has been model, we proceed to continue with the architecture. In this case it is appropriate to work with the View Model, starting with smart contracts. The different implemented smart contracts can be visualized in Figures 3 to 5. These are the ones that will act as View Model within the part on Architectural style MVVM. This logic can be programmed using some language that can be interpreted by the EVM. Before continuing, the following is clarified: you have 3 types of contracts and 3 types of actors. The first actor is the representative of the Electoral Council V. SOLUTION
and is responsible for using the Electric Process Contract the second is the representative of the jurors of the table, which interacts with the Voting Table Contract during election day, and the third is the voter, who also uses this "last contract". It is proposed that each of the tables located in specific locations, have at its disposal a Smart Contract (Voting Table Contract) whereby s you may communicate with a main contract (Electoral Process Contract) controlled by the Entity in charge of monitoring the electoral process, and in turn, they may communicate with a third contract called Token Vote Contract. The Electoral Process Contract will manage what is related to the initial configuration of the electoral process (creation of polling stations, candidates, authorization for the start and closing of the votes, enable the public scrutiny) being used only by the person who is designated by the Electoral Council. Polling stations and voters may use the Voting Table Contract to authorize votes and vote, respectively. Token Vote Contract, will have a record of the balances (number of votes) of each of the accounts of the different candidates and authorized tables, during the development of the electoral day. The advantages offered by Smart Contracts and the Ethereum Blockchain is the possibility of performing transactional operations that are atomic, that is, 'a transaction is made completely or the EVM reverses the changes' if any problem occurs. This can also be done manually, to undo changes when there are fraud attempts detected in the consensus. Another advantage is the subscription to events that are occurring in Smart Contracts, for example, issuing an alert when the electoral process is activated, making it reach some Front End or device, in order to mitigate fraud attempts. Finally, Smart Contracts can be configured to only accept connections from a specific network domain, in this particular case, voting stations.

5.2 Decentralised Application or D App

As a result of the design proposed in the previous sections, the development of the application presented is achieved. In the complementary material that is related in Section VI, you can visualize the different roles that are part of the electoral process, as well as the options to consult the final results, or by table depending on the case. Through the website in the voter may choose his candidate of preference, and once the table authorizes his vote, he may send it as a supporter or to the chosen candidate. This authorization is given through another interface using an Authorize Vote bot , a functionality that allows the voter to spend a token of the table balance and send it to a candidate as a support. Through there will be total control over the electoral process, allowing it to be managed. Once the election day has concluded, there is a public page, where anyone interested can know the results of the electoral process. This can also be done using another of the pages that is implemented, enabling 'consultations of the votes obtained by each candidate per table, in order to check the final results, complying with the principle of public and verifiable.

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VI. RESULT AND DISCUSSION

'Using the proof of concept as a starting point to have reliable data, and to make accurate judgments when evaluating these technologies in later sections, a table is made in which the different expenses in terms of gas and ether (known as ETH) are presented, the latter being the official currency of Ethereum; at the time of making each of the transactions, and as´ı, have an approximate value of how much each of these can cost.

As indicated, gas represents the computational cost required to execute a transaction and be added to the Blockchain, this cost allows to establish the economic value of executing each function of a Smart Contract. 'Table I presents the costs associated with each of the functions of the contracts used in the proof of concept.

It's important to be careful about the computational cost (gas) since it is not the same as the economic cost (ETH), since the computational cost is fixed while the economic cost is variable, and it is accepted to the fluctuation on like any other currency. For example deploy the contract Token Vote Contract has a cost in gas of 1,352,345, which in ether is equal to 0.0270469 as seen in Table I, this last value is the one that the miner credits to his wallet and will claim it in a transaction on based on his current quote.

Now that you have the different costs associated with each of the possible transactions that can be carried out by means of the proof of concept, we proceed to propose the different formulas to carry out the calculation of the cost of a whole´a voting day to. To be able to calculate the costs of the different transactions, Table II can be used. Some of the variables that are not defined in it are the following:

- p : current price of ether.
- e : cost of carrying out the transaction that is it evaluating´at the moment, in ether.

6.1 Discussion

Blockchain is a viable promise to be used in small electoral contexts, unless the rationing time of the election day is extended, since the mining compromises its performance and scalability. It should be clarified that this mining time is also its strong point to make the stored data safe, immutable, and transparent. The present in comparison with other works such as [6],´[7] and [16], proposes a similar form of electronic voting, avoiding linking the public key to the vote. In addition, the task of the voter to save the pair of keys to be able to vote in each electoral period is withdrawn, seeking to mitigate the inconveniences due to the loss of their keys. In the works cited in the present, there are a variety of proposals, however, the way to implement them is not mentioned, and they do not provide the software developed, unlike the present. This proposal does not allow coercion to voters, and´ can vote protected at voting points. Otherwise, if you vote from home, especially in hostile areas.

6.2 Implementation in America Latin

Blockchain has proven to have great flexibility of adaptation, so it can be implemented in supply chains, digital identity, transparency in government contracting processes, product traceability, transparency in an NGO, money transfers without intermediaries or electronic voting. This can be done through a company's own infrastructure or provided by a third party or in the cloud. To have better control over the transactions carried out on this technology, it is necessary for each government to issue well-defined policies for regulatory purposes in it.

VII. CONCLUSION

The consensus procedure, the absence of a central authority, added to the replication of information in each node, allows them to judge in equality´´´reoccur if the new block to be registered in the Blockchain doesn't rapid alter it, this promises the immutability of the stored votes, highlighting the viability of the technology in small electoral contexts. In addition, as everything in the Blockchain is public, anyone can count votes manually and corroborate with the final results, although it should be clarified that the operation doesn't allow the partial counting of votes during election day, only when public counting is enabled (in agreement with the principle of equity) by the Electoral Council. It is necessary to work on decentralized identities for different voters, so this is considered as a unborn job. Where a way is set up under the restrictions of the basic principles of voting that were raised in all other sections, to deliver a digital identity to the voter, without compromising their anonymity. For further information regarding the work reported, please https://github. com/Blockchain Voting Demo/Sistema electoral blockchain, a video of the 'proof of concept and source code of the operation' on´ is made available.

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