Electronic Universal Voting

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In the days of informational society everything is going online. Most aspects of our lives have online components. Since democracy is a big issue, it could not escape this trend. Governments themselves are moving to the online environment for the purpose of improving their internal efficiency and their availability to the citizens, businesses and other parties interested. Since governments are the result of elections, elections have also been touched by the electronic fever. New electronic voting solutions arise and each one brings new debates with many arguments in their favor and against them. Accessibility and ease of use leads the arguments in favor of electronic voting over the internet, while fear of fraud is the main reason people are avoiding electronics and clinging on classic paper ballots.
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Our lives are going online

At the dawn of 21st century everything goes "e-". The "e-" has evolved a long way from e-mail to almost e-everything. We communicate, work and entertain online.

Classic paper-back letters are becoming obsolete (how long since you wrote a letter?). We write only electronic messages, and we write a lot of them. There is e-mail, chat-rooms, forums, blogs. The newspapers that were once the main (even only) source of information are moving more and more to the online environment. Interactivity of the online environment attracts more people to this form of information (one may leave a comment on an article she/he reads and others will respond). Radio stations, that once replaced the newspapers as main source of information, are also going online. We listen to online radio stations (be them old or new) which gives us a very wide range of choices, since e-waves penetrated at far more distant places than classic radio waves. With the advances in technology, even television stations double their air transmission with an internet stream for everybody to see. There are still some quality issues, but they will be overcome soon.

The telework concept [Ghilic, 2002] has moved working to the electronic environment for many people. The hardships involved in daily commuting have lead people to work from home, via electronic means (mostly internet, but also phone and other means of communication).

Classic entertainment is still available, but online entertainment is proliferating. Beside online radio and television stations (that also count for information sources), there is a wide range of internet sites that provide entertainment. They go from internet libraries of still images and video clips, to online games, massive multiplayer games and even more sophisticated games that try to double our very own existence. Sites like Second Life [SecondLife] recreate our real world, with far less restrictions, in an online environment and develop it beyond real possibilities. According to the Second Life site, there are several millions of residents from around the globe that actually live an online second life. Some of them even spend more time in this world than in the real one. This world provides art, culture, fashion, communities, full economy (from its own currency, real estate transactions, manufactures, shops of every kind to a stock exchange). One of the last additions to this virtual world is the replica of the city of Bucharest, with its buildings, shops and so on.

What is the next level? We have reached the point where much debates arise about e-government, e-democracy, e-administration. Our very state organization goes online! E-government involves the use of internet technology in order to provide information, ser-

vices and transactions between different branches and agencies of the government or between those units and the citizens and businesses. The purpose is to improve the efficiency: of the government itself, of public services delivery and of the democratic processes in general. The main forms of e-government are: Government-to-Citizen (G2C), Government-to-Business (G2B) and Government-to-Government (G2G). There are some basic interactions involved in all these forms ([Brown, 2003], [Palvia, 2007]):

1. publishing information over the Internet (legislation, regulatory services, general holidays, public hearing schedules, issue briefs, notifications etc.);
2. two-way communications between the government units and the citizens, businesses or other government units. Communication may be initiated by any of the sides;
3. conducting transactions (lodging tax returns, applying for services and grants etc.);
4. governance (online polling, voting and campaigning).

Polling and voting is one of the main issues of democracy. We vote to guide the government policy, to elect representatives at various levels (local, regional, national, supranational etc.). What is voting going to be like in the "e-" world?

Polling goes "e-" too?

We still use the old fashioned paper ballots, preprinted with the available options. The voter uses a stamp to mark his choice on the ballot and then inserts it into a box. When voting session is over, a committee opens the box and hand counts all the ballots. Then the results are written on another piece of paper, verified and signed and collected. On several levels, various committees add up the results from the reports they receive and finally present the voting day result. Most of the countries still use this way of voting, although some of them or at least some parts of some countries (some states or regions in the US), are trying to bring 21st century technology into voting. Isn't this too slow, error prone and work intensive for the information society?

Even more, this system is not fit for the current state of facts. Let's take the example of Romania (maybe other countries too): because of current legislation, a person may live and work in a city for many years, but he/she must go vote in another city far away. It is an effort and sometimes it is not deemed worthy, so the person just gives up voting. Some countries implement a mail-voting solution to overcome the distance problem: voters that are far away send their ballot in advance in closed envelops through mail and their choices are counted along with the others.

Other countries have pioneered the use of electronic voting, even over the internet. United States uses some form of electronic voting since the 20th century, with 7.7% voters using such systems even in 1996 ([US FEC]). They mainly use "Direct recording electronic" voting machines (DRE). This technology is also used in Brazil, Venezuela, India and Netherlands. Internet voting is already used in United States, United Kingdom, Ireland, Switzerland, Canada, France and Estonia. Each country has its own approach for internet voting. For example in Switzerland, voters receive their access passwords for the internet voting system through mail. Estonia uses advanced national identity cards equipped with electronic chips that can be read by computers. These cards are used to access the internet voting system during early voting days. In the election day only classic paper ballot system may be used. Other countries that use at least some form of internet voting are: Australia, Belgium, European Union, Finland, France, Germany, Italy, Norway ([EVote, 2008]).

Accessibility

Accessibility is the reason behind the development of electronic voting. On voting day polling centers are often crowded beyond their possibilities to accommodate voters, so people may not be able to vote before closing time. The time limit must be extended with all kind of complications. Also, there are people that can not present themselves to the polling centers: some are impaired; some are

too far away to make the trip (or they are not allowed to make the trip, like soldiers and other types of personnel performing missions abroad). For the impaired people various adaptive technologies are implemented to help them vote.

Voting machines evolution

From the classical paper ballot to the internet voting, the path has been marked by several advances.

First came the idea to replace manual counting of ballots with some form of automatic counting.

Punch cards are paper ballots that have predesigned positions corresponding to choices/candidates and voters punch a hole in the position corresponding to their choice. The cards are fed (immediately or later) to a device that identifies the holes and counts the choices. According to the US Federal Elections Committee, in 1996 37.3% of voters used some form of punch cards during presidential elections ([US FEC 2]).

Another technology requires voters to make a mark on the paper next to their choice, instead of a hole. A computer identifies the choice using an optical scanner and tabulates them.

Another advance used various electronic devices to make the mark on the paper ballot. The voter does not make the mark himself, but rather indicates it to the electronic device which does the actual marking.

Some systems, called "direct recording machines" completely eliminate the paper form the voting process. They have a series of levers and switches that allow one voter to choose one candidate/choice. The machine counts every choice and presents the counters to the polling station committee. They record the results on a report and send it to the higher level.

On the next level, "direct recording electronic" voting machines replace mechanical components with electronic ones. They employ an electronic screen to present the choices to the voter and record his choice in electronic memory. Variations of DRE machines may print and individual paper ballot for each voter to allow him to verify his choice was properly recorded. Also, they may print the final result, at voting day's end. Votes may be electronically transmitted to a central station. Transmission may occur individually, for each voter, in batches, at preprogrammed moments or at the end of the day. Consolidated results may also be transmitted periodically or at the end of the day.

Public network direct recording electronic voting system use a public network like the Internet in order to connect the polling stations to a central station that counts the votes.

Problems to be solved

A public electronic voting system must implement solutions to solve several problems in order to be accepted by all parties involved. Some of those are closely related to the advantages of the electronic voting; some connected to the security issues.

Voting is based on the idea "one person, one vote". Therefore an electronic system must correctly identify each voter and allow only eligible persons to cast their vote, and they do it only once. All eligible persons must be allowed to cast their vote. How could an electronic system identify a person? There are many technologies, but they have limited usability for large scale public polls. Highest chances of implementation require electronic or biometrical identity cards (that are unique to the owner) and devices that can link them to the owner.

The system must ensure that all voters cast a valid vote. This means there should be an option like "I don't care" or "None of the above" among the choices, because often voters do not like any of the choices presented to them. Once a vote is cast, the system must record it without any possibility to alter it or eliminate it from the final count. Also, the system must only count the valid votes.

Secrecy is a big issue when it comes to voting, so an electronic system must respect this. Therefore nobody (authorities, organizations or individual) may be able to find how a person voted and no person may be able to prove how they voted. This is intended to

prevent buying and selling of votes.

The electronic voting system must be verified and certified by independent organizations or persons. Ideally, anyone should be able to independently verify the system, but this may not be possible, since it requires a certain level of knowledge and skills. Variations include allowing a voter to verify his own vote before it is recorded.

As this is one of their purposes, electronic voting systems must bring a higher convenience to voters. They must be able to vote from anywhere (without going to a polling station), at a moment of their choice (during the voting day), in one session, without delay, with minimal equipment and with no need for special skills.

Flexibility is another advantage to be sought. With electronic systems there is no need to print millions of paper ballots for each vote (and reprint them if there was a mistake) and then correctly distribute them to the right polling station. Polling questionnaires can be designed on the computer, tailored for each situation and correct versions assigned to the right polling stations. Also, there can be more question formats and even open questions, where the voter may write their own answers. Processing such answers is an impossible problem for traditional voting systems, while electronic processing could make them possible.

Thus, the same system is reusable for any number of elections, referendums or other public consultations.

Although the initial investment might be high, the reusability of the system guarantees an overall economy of public funds. Once the system is established, a new referendum, election or any other kind of public consultation only requires the design of a proper questionnaire and the definition of the eligible voters pool.

The range of problems is not exhausted by far. There are many details to be fixed for such a system, from the person identification methods to the cryptography protocols to be used.

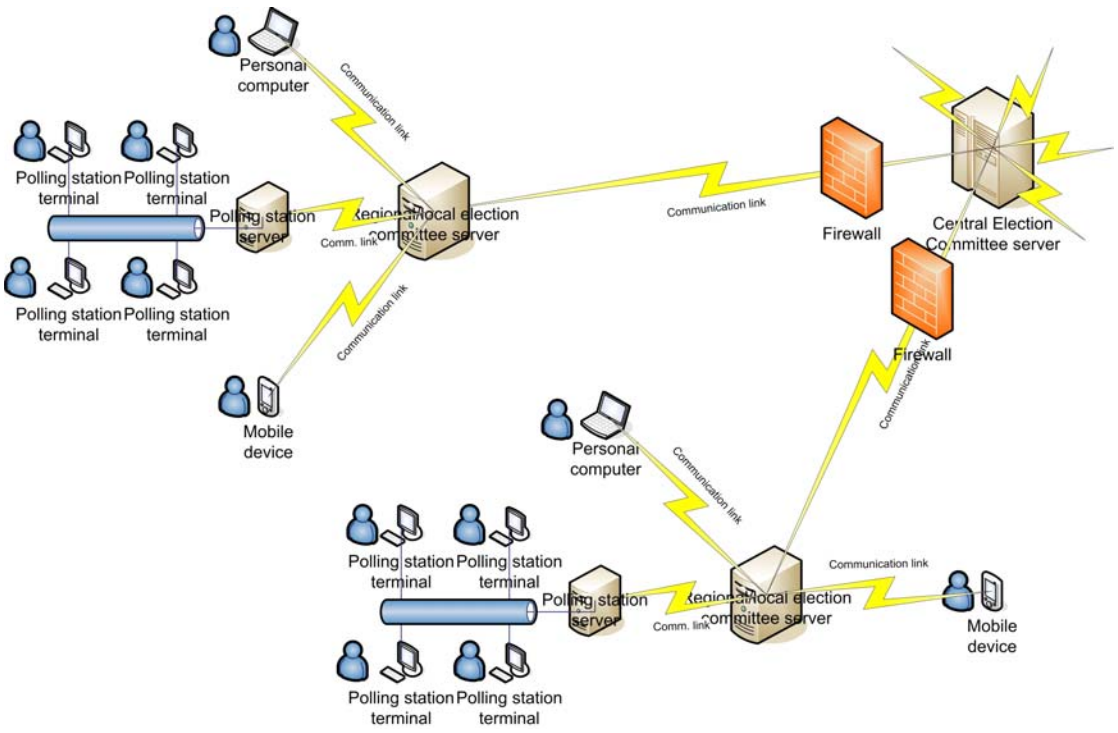

Fig.1. Universal electronic voting

Figure 1 presents a sketch of a universal public electronic voting system. Polling stations still exists. They present the voters with electronic terminals connected to a polling station server. All polling station servers are connected to the local/regional election

committee server in order to transmit their votes. Voters may also make their choice from distance, connecting to the regional server from their own personal computer or mobile devices that ensure correct identification of the user and allow or disallow them to vote depending on their eligibility and possibly previous voting in the same election/referendum.

Shall we or shall we not?

Beside the accessibility, electronic voting brings other advantages, such as accuracy, increased privacy, convenience, flexibility, mobility and speed. Elimination of hand counting ballots may allow for the final results to be known within minutes after voting day is over.

On the other side, there are many voices that express concerns regarding the use of electronic means for voting. Since the voting is an important mechanism of democracy, there is high concern regarding the results. The main problem is fraud. People fear that electronic voting systems are more prone to fraud than classic systems. Indeed, altering an electronic device may be harder than "altering" one person's choice, but the result could be a large scale alteration of voters' choices.

Concerns of fraud are not necessarily linked to human intention, but also to poor design of electronic voting machines and faulty functioning. There are cases of documented errors with thousands of votes lost without the possibility of recounting, as recent as the 2004 US presidential elections ([EFF, 2008]).

Between advantages and dangers of the electronic voting, there are a lot of visions. The extremes may be defined as a pessimistic vision and an optimistic vision. They could be summed up as follows:

- *Pessimistic vision*: there is no way to guarantee that an electronic voting system cannot be interfered with in order to change the results. There will be always someone powerful enough, with the desire, the will and the means to alter the scrutiny for his own purposes. No precautions could be taken to prevent every possible interference and there could be no guarantee all humans involved can be fully trusted.
- *Optimistic vision*: we must trust that the right people will be in charge of the electronic voting systems and they will perform their jobs with honesty and truthful to the values of democracy. They will act to prevent any and all outside interference, trough every means available and the final results will truly reflect the people's choice.

Conclusion and future work

Electronic voting is coming relentlessly. It is the logical evolution of the information society and there is no way we could keep voting as we did for the last 200 years. It brings many advantages both for the people and for the administration and it can help the democracy and increase peoples' trust. At the same time, electronic voting raises new concerns and fears of mass fraud. At this point we can jump headlong into electronic voting and face the problems (and possible disasters) or we can intensify the study of this matter. Directions of study are:

- the readiness of the population for the use of this technological advancement (since it must be used by all population at the same time): can it be implemented on large scale or should there be pilot projects and test stations first?
- technological details like identification of voters, ensuring one vote for each person, definition of eligible pool of voters, security and cryptography etc.
- economical aspects: costs and benefits, initial costs and long term costs compared to classic paper ballot system etc.

Disclaimer

This is not a pleading in favor of the online voting or against it. It is only the starting point for researches that hopefully will shed light on the matter and clearly define the need and possibilities of implementation for such a technology.

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