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Estonia's Experience with Online Voting
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In 2005, Estonia became the first country in the world to have nation-wide elections where people could cast legally binding votes over the Internet. This world premiere was followed by successful implementation of e-voting at all levels of elections: local, national and European Parliament. As of 2016, Estonia has held eight elections over ten years where people could cast legally binding votes over the Internet. This policy brief reflects on Estonia's experiences with e-voting. The brief begins by explaining the current e-voting procedures that are in place before elaborating on the historical development of Internet voting implementation in Estonia. I conclude with a discussion of key research findings on e-voting in Estonia and a brief discussion of how the country has dealt with the Constitutional challenges presented by the implementation of e-voting.

The cornerstone of Estonian e-services is the eID (Electronic ID Card). The feasibility of e-voting in Estonia is based on widespread Internet penetration and the use of digital ID cards (or similar available eID solutions). All Estonian citizens and residents above fifteen must have an ID card, which is issued by the government and contains certificates for remote authentication and digital signature. At present, the number of issued eIDs has exceeded 1 million.

In order to vote online, people are required to insert their digital ID card into a smart reader connected to a computer with Internet access. Following this, they need to download a voting app which is a standalone program for Estonian e-voting. Using their ID card and a four-digit pin (PIN1), the user has to first identify himself or herself to the system, after which the system checks whether the voter is eligible to vote in the election. The e-voting app encrypts the vote. In order to cast an e-vote, the voter has to choose a candidate and provide a separate five-digit pin (PIN2) to vote. When certified correctly, the electronic vote is cast and sent to the server where it will be counted. Before the ascertaining of voting results, the encrypted votes and the digital signatures (i.e. the data identifying the voter) are separated. The system opens the votes only after the personal data is removed. The scheme uses public key cryptography that consists of a key pair – a private and a public key. Once the vote is encrypted with a public key then it can only be decrypted with the corresponding private key. The National Electoral Committee, holding the private key, collegially opens the encrypted anonymous e-votes on Election Day.

The average e-voting session lasts well below 3 minutes in duration. E-voters can cast an unlimited number of e-votes during the seven-day e-voting period (from the 10th day until the 4th day prior to Election Day), with each new vote cancelling the previous e-vote by that person. During advance voting the voter can also vote on paper at the polling places, which cancels the e-vote. Only about 2% of e-voters vote multiple times which suggests that e-voting in Estonia does not introduce uncertainties into the advanced vot-

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ing period. Roughly 90% votes from abroad in Estonian elections are cast as e-votes.

In the upcoming 2017 elections, Estonia plans to update the more than 10 year-old technical framework by introducing additional measures for increasing verifiability and transparency without changing the user experience of the voter. Additional emphasis is being put on the continued use of trust-building methods like mathematical proofs and data auditing.

The history of e-voting implementation in Estonia can be divided into three periods: 1) the setup and implementation phase; 2) the years of increasing participatory numbers and additional legal debates; 3) the introduction of verifiability and a stabilized use of e-voting methods. The year 2002 marked the start of the setup phase, when a very general principle for remote electronic voting was stipulated under electoral law, allowing the election authorities to start with the project preparations. The first e-enabled elections (for local government councils) were held in October 2005. After the 2011 general elections, where almost a quarter of all votes were cast electronically, parliament decided to specify the legal norms of e-voting under electoral law in order to improve the legitimacy and transparency of e-voting. In 2012 parliament adopted several amendments to the electoral law, stating that a new electoral committee - the Electronic Voting Committee - was to be created for the technical overseeing of e-voting. The most significant change of the law came in 2015 when it was mandated that voters had to have the possibility to verify that their vote was received, stored at the central server of the elections and reflected the choice of the voter correctly.

A growing body of research has been produced examining the deployment of e-voting in Estonia. One of the key findings from this research shows that trust towards e-voting in elections is polarized. A substantial majority clearly trusts e-voting as a secure voting method, while a non-negligible part of the electorate does not trust it at all, and there is a large gap in-between these two poles. Regardless of the polarization, the overall trust level is still high. People who distrust the system are very unlikely to ever e-vote, so solutions that should produce additional confidence in e-voting, such as individual verification, will not influence them. Using individual verification does not bring a statistically significant increase in trust towards e-voting but offers a useful tool for the voters to get feedback about the computer used for voting.

With regard to the uptake of e-voting, research has found that the share of e-voters in the first e-enabled elections in 2005 was very low. Only 9317 votes (less than 2% of all votes) were cast online, meaning only every 50th voter e-voted. This number increased by approximately 4.3 percentage points with each subsequent election and reached an

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all-time high in 2014 when every third vote was cast online. By the last parliamentary election in 2015, user number had grown to 176 491. Like the growth of e-services in general, the growth of internet voting did not follow an exponential pattern, but rather a linear one which means that the conversion from paper-ballot voters to e-voters was almost constant over time.

In the first three e-enabled elections, e-voters were clearly distinct. They were younger, with better computer skills and mostly ethnic Estonians. From the third election onwards, these socio-economic differences started to disappear, meaning that e-voters became progressively less distinct from regular paper voters. Estonian e-voting log files between 2013 and 2015 suggest that e-voting is mostly used by middle-aged people between 35-45 years old, which is similar with paper voters. What stands out is that the e-voting turnout among 18-25 year olds is comparable to 70-75 year olds. E-voting is equally popular among males and females.

One of the key determinants for individual use of e-voting is electronic literacy. The more e-literate a person is, the more likely they are to be an avid user of e-voting. However, e-voting has not been shown to be a mobilizing factor for these e-voters to cast a ballot. This phenomenon explains the puzzle of large e-vote user numbers going hand-in-hand with very small changes in aggregate voter turnout numbers. The large overall numbers of e-voters shows that the intended ease of participation has been achieved by large numbers of habitual voters switching from paper ballots to e-voting methods. E-voting functions as a cost saving mode of participation in elections and is likely used when the cost of conventional participation increases. Citizens close to a polling station are more likely to opt for a paper ballot, but if the total distance is more than 30 minutes, e-voting is the more probable option. The attractiveness of a low-cost convenient voting mode seems to overcome social and technical barriers related to its usage. Research shows that e-voting is very persistent, with large shares of e-voters staying faithful to this way of participation in comparison to paper ballot or non-voters. E-voting once makes one very likely to vote this way in subsequent elections.

An often-debated issue in terms of e-voting is the question of how to ensure vote secrecy in unsupervised environments. To ensure that the voter is expressing their true will, they are allowed to change their electronic vote by voting repeatedly during advance polls. In 2005 the Constitutional Chamber of the Estonian Supreme Court reviewed whether the process of e-voting was in accordance with constitutional principles, mainly with the principle of equality. The central argument lay in the question of whether the e-voters' ability to change their vote by voting repeatedly electronically or once on paper would give them an unconstitutional advantage compared to the traditional on-paper vot-

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er. A possible lack of legitimacy of the election results could stem from the fact that the privacy of an individual e-voting procedure cannot be supervised or observed by authorities. Therefore, large-scale buying and selling of votes, as well as exercising other influence or pressure on the voter, could be possible. Moreover, voters themselves cannot verify the e-voting results, and voters need to have absolute faith in the accuracy, honesty and security of the electoral system. For people who did not take part in developing the e-voting system, the computer operations could be verified only by knowing the input and comparing the expected results with the actual output (similar to a black box). In a secret-ballot system, there is no known input, nor is there any expected output with which to compare the electoral results. Additionally, guaranteeing the freedom and secrecy of vote in an uncontrolled environment was also examined in the review process. Based on the remote nature, one of the cornerstones of free voting – mandatory privacy in the voting process – is not possible in Internet-based remote voting. The two sub-principles of secrecy of voting – privacy of voting and the anonymity of the vote - were analyzed by the Supreme Court. The court explained that to be found constitutional, Internet voting should provide a “virtual voting booth” – the possibility to change the e-vote in the voting process. It is important to emphasize that the constitutionality of the Internet as a communication channel, together with possible threats on anonymity and secrecy, was not analyzed in that particular case and has not yet been analyzed by the Estonian Supreme court.

In conclusion, Estonia has seen ten years of remote electronic voting mainly because of the voters’ trust in the possibility of conducting a wide array of processes over the Internet, and have different governmental services in the online environment, backed by the widespread and accepted eID solution. Internet voting in Estonia is not a special project to combat a specific problem with elections (e.g. youth participation) but an established part of a wider e-governmental landscape, a service the citizens expect to be offered in an e-society.

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