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INTERNET VOTING IN ESTONIA

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Abstract

Several countries have conducted Internet voting trials in binding public elections over the past decade, including Switzerland, the United Kingdom, and the United States. These trials have been conducted at the local and regional levels of government, targeting specific populations of voters. However, Estonia—a former Soviet republic and now a full member of the European Union—has advanced the farthest in deploying Internet voting. Since 2000, Estonia has conducted two national elections in which all voters could use Internet voting. The first election, in October 2005, was for local offices and the second election, in March 2007, was a national parliamentary election. In this article, we discuss the context for the Estonian experience in deploying Internet voting. We focus on how the Estonians have systematically addressed the legal and technical considerations required to make Internet voting a functioning voting platform, as well as the political and cultural framework that promoted this innovation. Using data from our own qualitative and quantitative studies of the Estonian experience, we consider who voted over the Internet in these elections, and the political implications of the voting platform. Finally, we consider the lessons that other countries can learn from the Estonian experience.

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Internet Voting in Estonia

Since the development of Mozilla, the software that made the Internet user-friendly, there has been an explosion in the use of and applications for the Internet. Not long after this dramatic expansion in the use of the Internet, many have wondered if it could be used to facilitate voting.[2] The rationale for Internet voting is simple; it is the ultimate in convenience voting. Anyone with a computer and an Internet connection can vote at the time that best suits them. Internet voting has not only been seen as especially promising for bringing young voters into the electoral process in the United States, where turnout is traditionally quite low; youth voting rates are abysmally low compared to all other age groups in many countries, but these same young people use the Internet at exceedingly high rates.

Some of the keys to making Internet voting work—or any mode of voting, such as early or absentee voting, or new voting technology—in any electoral jurisdiction is to have a legal structure, a technology infrastructure, and a political culture that is supportive of this voting mode. Consider, for example, the introduction of no-excuse absentee voting. It requires the election jurisdiction to have laws and procedures that allow for different forms of voter authentication (signature matching), different requirements for when people can vote (to accommodate ballot transit time in the mail), different requirements for security (how to secure ballots received in the mail that cannot be tabulated prior to election day), and clear rules for how and when the ballots will be counted. Internet voting has similar requirements that have to be met for its introduction to be effective. It requires clear rules for how voters will be authenticated, clear rules for when people can use the system, and clear rules for determining

[2] Much of this early history of Internet voting in the United States is covered by R. Michael Alvarez and Thad E. Hall, *Point, Click and Vote: The Future of Internet Voting*, Washington, D.C.: Brookings Institution Press.

when and how to tabulate the ballots. It also requires that the technology of the system itself—the Internet voting platform—be secured.

Most characteristics of Internet voting are far from revolutionary. Take postal voting, which has become trendy in various constituencies around the globe, certainly including the United States. Postal voting contains two particular features that pave the way for the introduction of Internet voting: the introduction of a *period of time* during which voters can cast a ballot and the possibility for the voter to do so *remotely*. The type of Internet voting we consider in this paper shares these features: one can cast a ballot remotely and for more than a few hours on voting day. Our discussion excludes the myriad systems of electronic voting that are based on direct recording electronic (DRE) voting machines that replace the traditional ballot box. What is revolutionary with Internet voting is the fact that ballots can be cast remotely via the Internet.

A handful of countries have conducted Internet voting trials over the past decade, including France, the Netherlands, Switzerland, the United Kingdom, and the United States. All of these trials have been conducted at the local and regional levels of government, targeting specific populations of voters. However, the nation that has advanced the farthest with the deployment of Internet voting has been Estonia, a former Soviet republic on the Baltic Sea and now a full member of the European Union.[3] Since 2000, Estonia has conducted two national elections in which all voters could use Internet voting. The first election, in October 2005, was for local offices and the second election, in March 2007, was for parliamentary elections at the national level. In this article, we outline the context for the Estonian experience in deploying

[3] There has been some analysis of Estonia's transition to democracy in the academic literature, for example, see Park (1994), Titma et al. (1998), Grofman et al. (1999), Grofman et al. (2000), Berg (2001), Brady and Kaplan (2001), Aalto and Berg (2002), Pettai (2004), and Taagepera (2006). See Drechsler and Madise (2002) for discussion of the early developments regarding Internet voting in Estonia.

Internet voting. We focus on the systematic way in which the Estonians have addressed the legal and technical considerations required to make Internet voting a functioning voting platform, as well as the political and cultural framework that promoted this innovation. Using data from our own qualitative and quantitative studies of the Estonian Internet voting process, we then consider who voted over the Internet, how Internet voting has been used in Estonian elections and the political implications of the voting platform. Finally, we consider the lessons that other countries can learn from the Estonian experience.

II. Internet Voting in Context

Experimentation with alternate voting methods is ongoing in Europe. The United Kingdom has conducted a broad set of trials with alternate voting methods, allowing individuals to vote in pilot projects using all postal voting, Internet voting, and sms-voting (text messaging from a cellular telephone). The move toward experimentation in the United Kingdom, and in other countries in Europe is summed up in the comment of respondents in focus groups held in the United Kingdom that stated that "voting using the Internet is tacitly accepted by most as 'the way forward' (at least in conjunction with other methods). Some see it as a logical and perhaps even inevitable development, especially in the context of the younger generation's perceived preference for communicating electronically" (UK Electoral Commission 2003, 66; Norris 2005).

Among the most advanced and early Internet voting trials, the canton of Geneva in Switzerland played a pioneering role. The United States and Switzerland are, in the literature, presented as the paradigmatic cases of low voter turnout among modern, liberal democracies (Franklin 2004). Also, the frequency with which Swiss voters have to express themselves at the

polls – at all levels of the federal state - is extraordinarily high, due to the widespread institutions of direct democracy (Kriesi and Trechsel 2008). It is therefore hardly surprising that Switzerland took a leading role in promoting new forms of remote political participation, be it via postal mail or over the Internet. As early as in 1998, the Federal government launched an e-voting initiative in which it invited three cantons (Geneva, Zurich and Neuchâtel) to lead pilot projects in this field (Auer and Trechsel 2001). In terms of numbers of binding decisions taken by the electorates over the Internet, the canton of Geneva so far has the largest experience in Internet voting worldwide. The Geneva experience also has been studied intensively by social scientists (Kies and Trechsel 2001, Trechsel and Mendez 2005, Trechsel 2007). The numerous surveys conducted so far could show strong support by the electorate and political neutrality of the voting channel; this has usually been coupled with scant evidence that Internet voting has increased turnout, though it may change the nature of participation, with former postal voters switching to Internet voting and remaining faithful to the latter in subsequent ballots.

The European experience with Internet voting can be clearly contrasted with the American trails of Internet voting. In the four major trials of Internet voting in the U.S.—in Alaska and Arizona in the 2000 presidential primaries, the 2000 general election through the Federal Voting Assistance Program's Voting Over the Internet Program, and the 2004 Michigan Democratic presidential primary—there was little or no effort to evaluate the efficacy of the projects at the time they were conducted or to build on the success (or address shortfalls) that arose in the deployments. In fact, three of these trials were instigated and run by private entities, a specific political party, and only one trial was even conducted by the government.[4]

[4] A complete discussion of these trials and their shortcomings can be found in Alvarez and Hall (2004). The Arizona trial was studied by Solop (2001) and Alvarez and Nagler (2001).

III. What Makes Estonia Internet Voting Work

Before discussing Internet voting in Estonia, it is helpful to explain the baseline voting method there; paper-based precinct voting. Like most of its OSCE neighbors, Estonia has early voting. From the 13th to the 9th days before the election, an individual can vote early in one of the advanced voting polling places; there is one such location in every municipality. In the 6th through the 4th days, a voter can vote early at a larger number of polling places; on election day (a Sunday), voters cast ballots in their home precinct. Voters cast ballots on a paper ballot, where they write in the number corresponding with the candidate that they support (as shown in Figure 1). Ballots are then hand-tabulated at the precinct, as shown in Figure 2, and these results are communicated electronically to the electoral commission the evening of Election Day after the polls have closed.

[Figures 1 and 2 here]

We now turn to Internet voting in Estonia. There are four key features to the Estonian experience that makes Internet voting a workable alternative: widespread Internet penetration, a legal structure that addresses Internet voting issues, an identification system that allows for digital authentication of the voter, and a political culture that is supportive of Internet voting. According to data from the European Commission, Internet access in Estonia is widespread and is increasing rapidly (from 31% of households with Internet access in 2004 to 53% in 2007); broadband access is widespread in Estonia, and Estonians are used to accessing their government services over the Internet.[5] The Estonians have a legal system that supports the development and use of Internet voting (Drechsler and Madise 2002). One of these key statutes is the Digital Signature Act (DSA) of 2002. The DSA, and related administrative legislation, allows

[5] The European Commission data show that Estonian e-government access ranks much higher than the overall found in the European Union, while the broadband penetration rate is slightly greater than the EU's overall penetration rate (current data is available on "Innovation and Research", at http://epp.eurostat.ac.europa.eu).

individuals to use approved digital signatures to authenticate themselves in online transactions (especially government transactions), including voting. Given the importance of authentication in any remote transaction, from banking to email, having a law that governs how and when such digital signatures can be used is critical to making a system like Internet voting work.

Estonia is not the only nation with a digital signature law. The United States, for example, has a DSA. However, in Estonia, this act is especially meaningful because, concomitant with the passage of the DSA, Estonia began the process of mandating and introducing an identity card that included a digital certificate embedded in the card that could be used for online authentication of an individual, when combined with the individual's unique personal identification number (PIN). The user uses the digital signature in the following manner. First, the user needs a smart card reader that fits into an available computer port. This reader, which costs approximately seven dollars ($7), can read the digital signature on the Estonian identity card. The user then connects to the Internet and goes to the government website that is the central portal for all government transactions. On this website, the individual's card and PIN are combined and the user is authenticated. A photo of an identity card being used to access the government's e-government portal can be seen in Figure 3.

[Figure 3 here]

The national identity card with a digital signature truly makes Estonia unique in that all citizens can utilize Internet voting. Even if an individual does not have her own computer with a reader, there are public computers with these readers that any Estonian can use. This can be contrasted starkly with the American experience where there is no system at the state or federal level to provide individuals with digital signatures. Even if there was such a system in the United States, where most state laws explicitly do not allow the use of digital signatures for

transactions such as registration or authentication in elections. Even in nations throughout Europe who have conducted trials of Internet voting, the lack of a nationwide digital signature program provides an obstacle that has to be overcome in the process of voter authentication. Note, however, that the Geneva trials – and since then the trials in the cantons of Neuchâtel and Zurich, where even voting by text messaging over mobile phones was recently tested – were conducted in the absence of nationwide digital signature regulation. These jurisdictions instead developed effective procedures to distribute appropriate authentication materials to voters through other means.[6] In other words, although it makes things easier for polities wishing for an introduction of Internet voting, the DSA is not a prerequisite for doing so.

With an authentication system in place, the second component of the legal framework that facilitates Internet voting was passed in 2002 (Drechsler and Madise 2002). A series of statutes—the Local Communities Election Act, the Referendum Act, and the *Riigikogu* Election Act—were passed in March and June 2002. Each statute enabled the use of Internet voting in specific types of Estonian elections and specified the administration of such elections. The time period when voters could cast Internet ballots (the sixth to fourth days before the election date), the authentication process, the process for ensuring that Internet voters do not cast ballots on election day, and the process for reconciling all ballots at the end of the election were specified in these laws. These statutes have been interpreted by the Estonian courts as meeting the requirements under the constitution for "free elections…[that are] general, uniform, and direct. Voting shall be secret." Voters who cast ballots using the Internet are doing so during a period of early voting. If, for some reason, a voter was concerned that the privacy of their ballot had been compromised, the voter can still cast a ballot in an early voting location. By rule, voters

[6] We would note here that Western nations generally have much more effective voter registration systems that have fewer errors than do voter registration systems deployed in the various states in the United States.

who vote in early voting electronically and by paper have their paper ballot counted, which helps to mitigate problems of coercion and fraud.

Other important safeguards are built into the Estonian electoral system that likely enhances the confidence of all key stakeholders in the integrity of ballots cast over the Internet. The Internet mode of voting is optional, and is in fact one of three ways eligible Estonian citizens can cast a ballot in a national parliamentary election like the 2007 one. They can cast an Internet ballot, they can cast an early vote ballot on paper (during the early voting period discussed earlier), or they can vote in person on Election Day. Importantly, furthermore, Internet voters can change their vote as many times and at any moment during the Internet voting period electronically. Note, however, that such a reversible voting mechanism is not an Estonian innovation, as it exists, for example, in Sweden (for postal voting). Estonian voters may even cast a paper ballot if they desire; the *Riigikogu* election law for the 2007 parliamentary election requires that the last Internet ballot be eligible for counting, but only if the voter has not also cast a paper ballot. If a paper ballot has also been cast by the voter, the paper ballot was the ballot of record in the 2007 parliamentary election.

Internet voting in Estonia has also been facilitated by the overall level of political, public, and administrative support that it has received. The initial proposals for Internet voting were made by the Estonian Prime Minister and the Minister of Justice. Their decision to champion this provided a high level of support for overcoming any initial hurdles for implementing Internet voting. Although there have been governmental changes since this initial legislative initiative was made, Internet voting remains a voting mode that almost all parties support. In addition, Internet voting has had strong champions within the Estonian government's administrative structure. As we show in the following sections, the public too has championed Internet voting,

with more than 30,000 individuals voting via that platform in the 2007 parliamentary elections. It is important to note that Internet voting did not fall from the Estonian skies. It belongs to a larger, many years old effort to develop the information and communications sector in the economy as well as to put the Internet at the very heart of intra-governmental activities (e.g. the Estonian government is very proud about its "paperless government") and government-citizen interactions. Therefore, many experts in the information and communications technologies (ICT) sector humorously refer to this country as "e-Stonia".

VI. Brief Introduction to the Estonian Internet Voting System

We had the unique opportunity to observe the Estonia 2007 elections in person, and to both be part of the formal briefings and other events that the Estonian National Election Commission conducted for the many international election observers who were on hand to witness the use of widespread Internet voting in this national election. We also had an opportunity to observe tradition polling place voting in Estonia, as conducted on Election Day, so that we could compare the procedures associated with traditional paper-based polling place voting in Estonia with the Internet voting alternative (Trechsel et al. 2007). In addition to our work, other international organizations also studied the Estonian Internet voting system (OSCE 2007).

Internet voting in Estonia occurred during a three-day period, during the broader early voting period. Estonian voters who wished to vote over the Internet needed their Estonian national identification card, as well as their personal identification numbers (PIN) associated for use of the card. Also, they had to have an Internet-accessible computer, which had a working smart-card reader attached. So equipped, potential Estonian Internet voters went to the appropriate website (www.valimised.ee) and from there began the process of authenticating

themselves to the system, obtaining a ballot, and voting.[7] This began with them being prompted to insert their identification card into the reader, and to type in their first PIN. At that point the voting server would query a server with the voter registration database; pending authentication of the voter they would be sent to a page that provided their candidate list. There they could select their candidate from the list, confirm their choice, and provide their second PIN. At this point some of the magic of cryptography entered into the process; the voted ballot was encrypted, and upon voter confirmation and provision of the second PIN the voter would effectively "sign" something like a digital version of an absentee ballot "envelope"; this "envelope" containing the voter's identity would later be disassociated from the voter's actual ballot if it were confirmed that they had not cast a paper ballot. Pending completion of this process, one of the voting servers verified that the digital signature of the voter is indeed correct, and if so, would pass the entire encrypted ballot to another server where it would be stored until tabulation. At this point, the voter would receive a confirmation message on their browser.

If the election commission received information from an advance voting polling place that any of the Internet voters had also voted a paper ballot, that voter's Internet ballot would be electronically tagged so it would not be counted on the night of the election. Interestingly, the counting of all of the Internet votes took place within the last sixty minutes of polling place voting on Election Day in a room in the Estonian Parliament building. In order to insure that none of the results from the Internet vote tabulation could be broadcast to media, candidates or parties until after the polls had closed, all communication devices of observers were confiscated,

[7] For interested readers, the Estonians used a number of procedures at this stage to mitigate some of the threats commonly associated with Internet voting systems. First, the url of the website from which they could access the Internet voting applications were published, and voters were urged to go to the website by typing the url into their browser themselves --- not to go to the website by clicking on a link in an email. Second, the server certificate was publicly available, and e-voters were urged to check the certificate of the server they were using with the published version. Finally, Estonians were urged to make sure that the computer they were using was free of viruses and other malware before engaging with the Internet voting application.

the doors to the room sealed, and security guards posted at the doors. Only the Internet votes from qualified voters who had also not cast a paper ballot were included in the tallying of the Internet votes, a process that involved decrypting the Internet ballots using a secure hardware module (this process required the use of multiple physical keys, most of them held by members of the Estonian National Election Committee). The decrypted ballots were then placed on a cd-rom, and were then tabulated by the Election Committee in view of the media and observers, including auditors from the firm KPMG Baltics, which audited this process. When the Election Day polls were closed, the Internet votes were added to the tallies that started coming into the Election Committee from polling places throughout Estonia.

VII. Internet Voting in the 2007 Election: Aggregate Data

We start our quantitative analysis by using the official statistics on the 2007 election provided by the Estonian National Election Committee. In Table 1 we show the basic statistics from the election, in which 897,243 registered voters were eligible to participate. Of those registered voters, 62% turned out to vote in person on election day, in person in advance of the election, or over the Internet. There were a total of 31,064 e-votes cast in the 2007 election, of which 789 were repeated e-votes --- thus there were 30,275 unique e-voters in the election. Interestingly, recall that Estonian e-voters could have their e-vote canceled by casting a paper ballot; only 32 of those cancelled e-votes were recorded in this election. In the end, e-voter turnout was 5.4% of all voters, 3.4% of eligible voters.

[Table 1 Goes Here]

In Table 2 we provide some data for the e-voters by gender and age, aggregated data collected by the Estonian National Election Commission. There we see very little difference between men and women in e-voting use: 51.8% of the Estonian e-voters were male, and 48.2% were female. Also interestingly, we do not see a strong skewness in the age distribution of Estonian e-voters toward the younger generations: Eleven percent of the Estonian e-voters were aged 18 to 24, with 17% aged 25 to 29. Notice, though, that 16% of the e-voters were older than 55, with another 27% between the ages of 40 and 54. Thus, based solely on the simple demographic statistics we can obtain about Estonian e-voters from the election authorities, we see little initial evidence of any particular demographic skewness in the data.

[Table 2 Goes Here]

Furthermore, aggregate e-voting data is available to us broken down by party. We give that in Table 3, with the first column of data giving the partisan breakdown for only e-voters and the second column giving the partisan breakdown for the entire electorate. We see here that there are few major differences between the partisan distribution of the e-vote and the overall vote; generally speaking there is a strong correlation between votes in these two columns (Pearson correlation coefficient of .836). There are some exceptions: the Eesti Keskeraknod party picked up 9.1% of the e-votes, but 26.1% of the total vote. But generally what we see is that of the four parties receiving more than 10% of total votes cast, all but the Eesti Keskerakod received a larger fraction of votes from e-voters than from the total electorate. Only one other party had a reasonably greater percentage of e-votes relative to total votes, the Eestimaa Rohelised party, which received only 7.1% of the total vote, but 10.7% of the e-vote. Note that

given the (for the moment) low overall turnout on the Internet, these differences did not significantly affect the political landscape of the newly elected Estonian Parliament.

[Table 3 Goes Here]

V. Who Voted Over the Internet: Survey Data

There have been two comprehensive studies conducted of Internet voting in Estonia, one after each of the two nationwide implementations, mandated by the Council of Europe.[8] The reports for each report are available from the Council of Europe (CoE) and contain a more detailed analysis of the election. Both of these studies involved conducting surveys of voters in Estonia, with an over-sample of Internet voters, in order to gauge the effect of Internet voting on Estonian politics.[9] We are currently writing a book-length work on Internet voting in Estonia but here we want to summarize several important issues related to the Estonian experience on the vanguard of the Internet voting revolution.

When we consider who e-voted using our survey data from our CoE study, we find several important results that suggest that, with only one exception, e-voting enhances participation for some groups. First, compared to other modes of voting, e-voting is more attractive for younger voters and less so for elderly people. This trend raises the question whether there will be a replacement effect, with more reluctant elderly voters simply disappearing over time and younger Internet voters replace them, creating a much larger Internet electorate. Second, and somewhat problematic, there is a language barrier in Estonia for Russian

[8] Alexander H. Trechsel was the lead investigator on both of these reports. Alvarez and Hall were co-authors of the second report which was mandated by the Council of Europe in conjunction with Estonia's National Electoral Committee.
[9] The methodology for both surveys can be found in the CoE reports.

speakers. Although Estonia is a multi-lingual society, Estonian is the official language; therefore, the e-voting system is provided only in Estonian. This seems to have created a strong barrier to the very large proportion of native Russian speakers among the Estonian electorate, most of whom did not vote over the Internet. Third, citizens with higher levels of computing knowledge use Internet voting more often. This is not necessarily a problem of access to the Internet—Estonia has very high rate of Internet penetration and use of technology—but more tech savvy citizens choose the e-voting option. Fourth, trust in the e-voting mechanism is critical to voting online. Only if a person trusts that e-voting will record one's vote correctly and produce accurate results will they use the system.

Given international concerns about digital divides, the fact that the Estonian system is neutral with respect to gender, income, education, and geography is very reassuring. This finding suggests that the e-voting system does not introduce undemocratic biases into the electoral process, in particular, biases that are fundamentally socio-economic. The e-voting system also does not introduce political bias, either. When other factors are controlled for, there is, for example, no left-right political bias among e-voters. Given that there is typically a concern that electoral reforms are introduced by parties in order to promote a specific bias in the process, the lack of bias in the introduction of e-voting is promising. Note that earlier studies conducted on e-voting in the Swiss cantons of Geneva and Zurich found a very similar pattern: be it in referendums or in elections, the introduction of e-voting remained politically neutral.

We also see from both objective and attitudinal data that e-voting is convenient for voters. Of course, compared to the American voting experience, Estonian elections are quite convenient because the vote is held on a Sunday, and not during the workweek. With this in mind, when we look at the time of day individuals voted online, we see that almost one-quarter

of voters (23.4%) cast ballots when the polls would have been closed. We also considered other ways in which the Estonian e-voting system promoted convenience. First and foremost, 85.8% of Internet voters said that they voted online because it was convenient. Among traditional voters, it was a hardware barrier, not an attitudinal one that kept them from voting online. Lack of a card reader, an electronic ID card, an Internet connection, or a computer accounted for more than half of all reasons why individuals did not vote using the Internet.

Second, there is some evidence from our surveys that e-voting may mobilize more casual voters—those individuals who state that they either vote "from time to time" or never. Small but significant percentages of the voters (~11%) who cast ballots online state that they "probably wouldn't have" or "for sure wouldn't have" voted if Internet voting had not been an option. Importantly, more than 20 percent of Internet voters in 2005 fell into these two categories. The individual level analyses of the 2007 Estonian elections also reveal a "faithfulness effect": a very large proportion of those voters who voted over the Internet in 2005 continued doing so in 2007. In fact, our data shows that without any exception all e-voters who declared having voted over the Internet in 2005 (and who were again among those surveyed in 2007) voted over the Internet again in 2007. A very similar finding was revealed in two consecutive referendum votes in the Swiss canton of Geneva, where Internet voting became the preferred mode of participation for almost any voter who used this channel previously.

In 2007, we also examined the use of the Internet as a tool for voters to learn about candidates and parties and as a tool that parties and candidates can use to target voters. As shown in Table 4, we find that voters are more likely than non-voters to use the Internet to learn more about the campaign, although 30 percent of non-voters also read about the campaign online. In almost every case, voters used the Internet more than non-voters for campaign

purposes. When we examine voters more carefully, we find that Internet voters are greater consumers of online information compared to both election day voters and advance polling station voters. Internet voters were 20 percentage points more likely to have read about the elections online and to have used the Internet to inform themselves about politics compared to traditional election day voters. Online information about candidates and political parties was used by almost 30 percent of voters and 37 percent of Internet voters in their search for election information and almost 24 percent of voters and 30 percent of Internet voters used the Internet explicitly to find information about whom to vote for. Internet voters bring their ICT skills to all aspects of the electoral process, not just the process of voting. We also see small but important differences between advance polling station voters and election day voters, with advance voters also more likely to use the Internet to learn about politics and the elections.

[Table 4 Goes Here]

When we examine new modes that political parties can use to communicate with potential voters—such as blogs, emails, videos, or online commentaries—we find that there are few differences among voters and non-voters or among voters voting online or in a polling station. Voters and non-voters alike watched campaign video clips online, which suggests that this is a medium that can penetrate to the non-voting population even if it may not have motivated them to cast a ballot. Voters, especially Internet voters, were slightly more likely to watch these online videos compared to non-voters. Only a small number of voters signed up for emails or posted information about the election online.

The Future of Internet Voting: Lessons from Estonia

Relative to the situation a decade ago, when many observers, dazzled by the promise of the Internet and the dot-com boom, wondered how one could implement remote voting over the Internet, we now have a series of case studies from a number of nations that have conducted serious trials of remote Internet voting. Perhaps the most impressive of these national trials has been the case of Estonia, as just over 30,000 Internet votes were cast in the 2007 parliamentary election. The question at this stage is what lessons can be drawn from the Estonian case?

One important lesson concerns the context. Estonia is a small and highly centralized nation. The 2007 parliamentary elections, while contested, were not the same sort of highly partisan and ideologically polarized affairs that have characterized American elections since 2000. Other important contextual variables in the Estonian case are two features of their election administration practice observed in the 2007 election: a comprehensive voter registry and a very simple ballot. With a comprehensive and accurate voter list, the process of voting, no matter what mode the voter used, was made much less complex than in other nations, especially the United States, where inaccurate and problematic voter registration procedures and registries are known to keep otherwise eligible individuals from casting ballots. With a simple ballot, where Estonians only had to cast a single parliamentary seat, much of the potential complexity of election administration --- including the design and implementation of a remote Internet voting system --- were reduced or eliminated.

A second important lesson is that successful attempts to deploy Internet voting systems require an adequate legal and regulatory framework. Ranging from the enabling legislation for Estonian national identification and the use of digital signatures, to a careful and deliberate political process that scrutinized the notion of remote Internet voting before initial deployment in

2005, it is clear that an appropriate legal and regulatory framework is a key lesson from the Estonian case. Nations that wish to emulate the Estonian example, and to pursue the development of an Internet mode of remote voting, will be well served to follow the Estonian example and to develop an appropriate regulatory and legal framework for remote Internet voting.

A third lesson regards voter authentication, which is the subject of debate in many nations, including the United States. In Estonia, the introduction and dissemination of their digital national identification card has opened the door for many uses of that identification, uses that pre-date the implementation of Internet voting in Estonia. In other words, having a strong form of online voter authentication may be a critical step for implementation of secure Internet voting that has the trust of voters and other stakeholders in a particular nation's election process. But it is unlikely that a strong form of voter authentication like that used in Estonia will be developed only for Internet voting; rather, it is likely that governments will develop and implement these forms of strong digital identification to enable citizens to interact with government in other ways: paying fines, fees and taxes; checking out library books; or researching property transactions. Although Estonia has been rapidly developing applications for their identification card, like Internet voting, they did start with other applications for their national digital identification first, allowing citizens and stakeholders to get used to the use of the identification card and authentication process before using it for applications like voting. Other examples of this implementation model exist, for example, the Canton of Neuchâtel in Switzerland. Neuchâtel does not provide citizens with the same form of digital identification but they have developed an innovative government e-portal with secure means of citizen access; only after the e-portal there was widely used for other purposes did Neuchâtel begin to use it for

Internet voting. These examples are also ones deserving additional research and analysis, as they might prove to be a successful model for introducing a wide range of government services over the Internet, including (but not restricted to) voting.

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Figure 1: An Estonian Ballot

(Note that one ballot was cast blank and one is clearly a protest vote (candidates are listed by 3-digit numbers)

Figure 2: Counting Paper Ballots in Estonia

(Ballots are stacked by candidate number. Each stack is then counted, bundled, and the total written on the outside of the bundle.)

Figure 3: Estonian Digital Signature and E-Government Portal

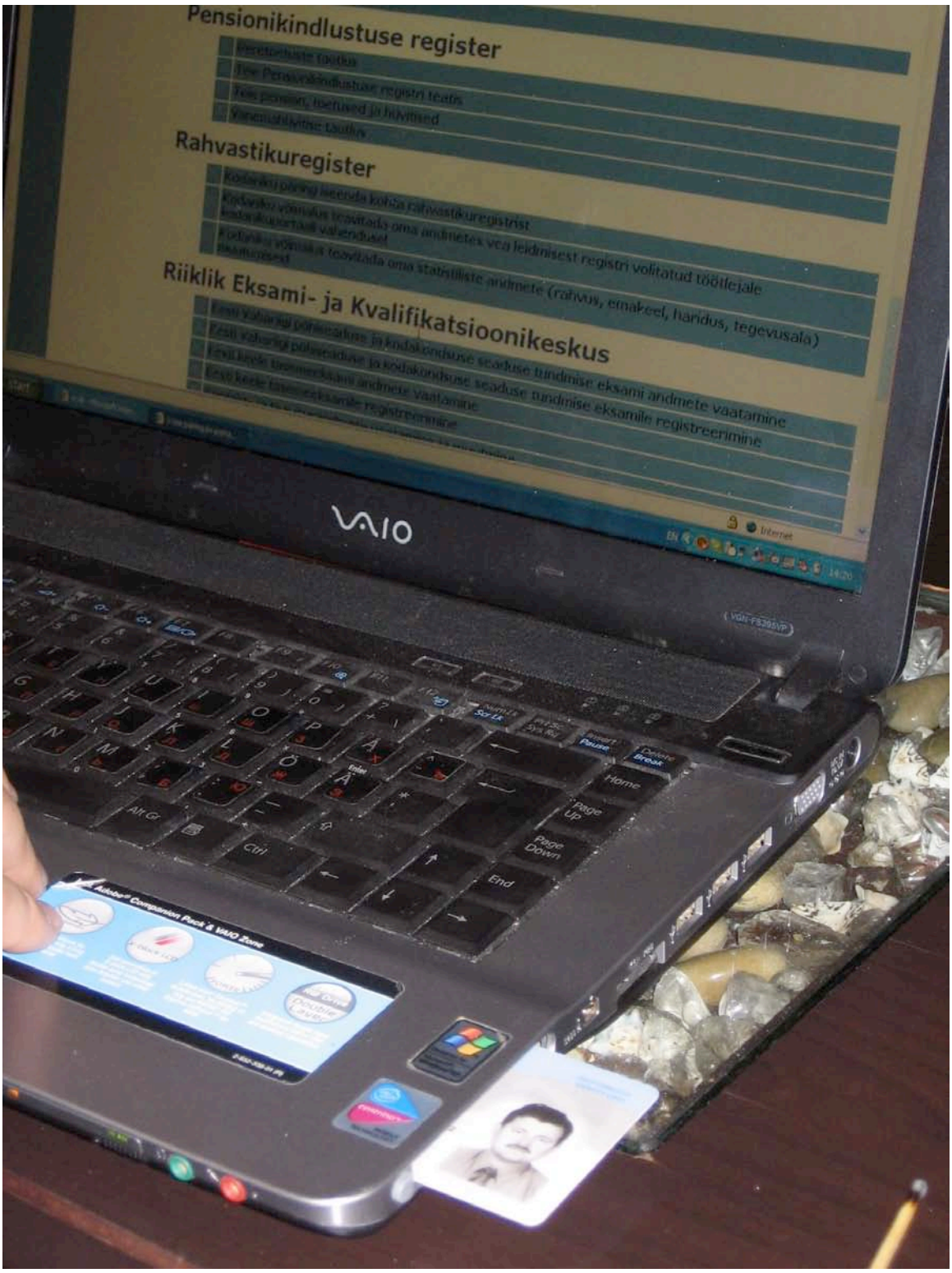

Table 1: Overall Statistics: Estonian E-voting 2007

Registered voters	897,243
Votes	555,463
Valid (e-votes included)	550,213
Invalid	5,250
Turnout	62%
Number of e-votes cast	31,064
Repeated e-votes	789
Number of e-voters	30,275
E-votes canceled by paper ballot	32
E-voting turnout (e-votes/eligible voters)	3.4%
E-voters among all voters	5.4%
Advance voting turnout (of eligible voters)	19.10%
E-votes among advance votes	17.70%
Number of e-voters who used ID card electronically for the first time	11,894
Percentage of e-voters who used ID card electronically for first time	39%

Source: Estonian National Electoral Commission, "Parliamentary Elections 2007, Statistics of evoting".

Table 2: Estonian E-Voting, By Gender and Age

	Women		Men		Total	
	N	%	*N*	%	*N*	%
Less than 24	1,551	10.63%	1,835	11.72%	3,386	11.20%
25-29	2,346	16.08%	2,753	17.59%	5,099	16.86%
30-34	1,970	13.50%	2,618	16.72%	4,588	15.17%
35-39	1,766	12.11%	2,152	13.75%	3,918	12.96%
40-44	1,474	10.10%	1,663	10.62%	3,137	10.37%
45-49	1,447	9.92%	1,371	8.76%	2,818	9.32%
50-54	1,281	8.78%	1,104	7.05%	2,385	7.89%
55-59	984	6.75%	853	5.45%	1,837	6.07%
60 Plus	1,769	12.13%	1,305	8.34%	3,074	10.16%
Total by Gender	14,588	48.24%	15,654	51.76%	30,242	

Source: Estonian National Electoral Commission, "Parliamentary Elections 2007, Statistics of evoting".

Table 3: E-Voting by Party

E-voting by Party	% of E-votes	% of Total Votes Cast
Eesti Reformierakond	34.5%	27.8
Isamaa ja ResPublica Liit	26.7%	17.9
Sotsiaaldem. Erakond	13.3%	10.6
Eesti Keskerakond	9.1%	26.1
Eestimaa Rahvaliit	3.6%	7.1
Eesti Kristlik Rahvapartei	1.1%	1.7
Konstitutsioonierakond	0.4%	1
Eesti Iseseisvuspartei	0.3%	0.2
Eesti Vasakpartei	0.1%	0.1
Vene Erakond Eestis	0.1%	0.2
Eestimaa Rohelised	10.7%	7.1
Independent candidates	0.1%	0.1

Source: Estonian National Electoral Commission, "Parliamentary Elections 2007, Statistics of evoting".

Table 4: Internet as a mode of education: Averages by mode of participation

	(In Percent for those Answering "Yes")				
	Did you vote in the 2007 national elections in Estonia?		How did you vote in these elections?		
	Yes	No	Voted On Election Day	Voted In Advance Polling Station	Voted By Internet
In the months leading up to the Parliamentary elections, did you hear or read anything online about the parliamentary elections?	**55.41**	**30.43**	**40.52**	**50.94**	**62.91**
Do You use the Internet in order to inform yourself about politics?	**41.65**	**21.12**	**27.45**	**32.08**	**49.55**
Volunteer online to work for a campaign	2.57	0.62	2.61	3.77	2.37
Look for more information online about political party or candidates' positions on the issues or voting records	**28.10**	**13.04**	**13.73**	**12.00**	**37.20**
Look online for whom to vote	**23.60**	**11.80**	**11.56**	**18.37**	**29.76**
Participate in online endorsements or ratings polls	**20.79**	**6.83**	**9.52**	**18.37**	**26.19**
Use the Internet to check the accuracy of claims made by or about the political party or candidates	**14.04**	**5.59**	**7.48**	**12.24**	**16.96**
Watch video clips about the political party or candidates or the election that are available online	11.24	9.32	9.52	10.20	11.90

Note: bold-faced entries are instances where a chi-square test for the observed row frequency comparisons are statistically significant, $p<.05$. Source: Trechsel et al. 2007.