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The Evolution of E-voting: Why Voting Technology is Used and How it Affects Democracy

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Declaration: Hereby I declare that this doctoral thesis, my original investigation and achievement, submitted for the doctoral degree at Tallinn University of Technology, has not been submitted for any other degree or examination.

/Robert Krimmer/

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LIST OF ORIGINAL PUBLICATIONS

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II Volkamer, Melanie and **Robert Krimmer**. 2006. "Die Online-Wahl auf dem Weg zum Durchbruch." *Informatik-Spektrum* 29(2), 98-113. (1.2)

III Edelmann, Noella, **Robert Krimmer** and Peter Parycek. 2008. "Engaging Youth through Deliberative e-Participation: A Case Study." *International Journal of Electronic Governance* 1(4), 385-399. (1.2)

IV Helbach, Jörg, **Robert Krimmer,** Nils Meissner, Anastasia Meletiadou and Melanie Volkamer. 2007. "Zukunft von Online-Wahlen – Aktuelle rechtliche, politische, soziale und technisch-organisatorische Fragen." *Datenschutz und Datensicherheit* 31(6), 434-440. (1.2)

V Alkassar, Ammar, **Robert Krimmer** and Melanie Volkamer. 2005. "Online-Wahlen für Gremien: Wahlen in Gremien als Einsatzgebiet für Wahlen ohne vertrauenswürdige Instanz." *Datenschutz und Datensicherheit* 29(8), 480-483. (1.2)

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VII Krimmer, Robert and Melanie Volkamer. 2005. "Bits or Paper? Comparing Remote Electronic Voting to Postal Voting." In *EGOV 2005*. Schriftenreihe Informatik 15. Linz: Trauner, 225-232. (3.4)

VIII Krimmer, Robert. 2006. "Electronic Voting 2006." *Proceedings of the 2nd Conference on Electronic Voting*. LNI P-86. Bregenz: GI. (4.2)

IX Krimmer, Robert and Melanie Volkamer. 2006. "Observing Threats to Voter's Anonymity: Election Observation of Electronic Voting." In *EGOV 2006*. Schriftenreihe Informatik 18. Linz: Trauner, 43-50. (3.4)

X Krimmer, Robert and Ronald Schuster. 2008. "The E-Voting Readiness Index." In Robert Krimmer and Rüdiger Grimm. *Electronic Voting 2008*. LNI P-131. Bregenz: GI, 127-136. (3.4)

INTRODUCTION

Scope and aim

This dissertation aims to contribute to the research that addresses the challenge of ensuring effective participation in decision-making procedures using information and communication technologies (ICT) in twenty-first-century democracies, which are assumed to be the best form of government available (UN 1945; EU 1993). The use of ICT in elections, also often called electronic voting (hereinafter: e-voting)[1], touches upon core principles in the governance of the contemporary democratic state. One might go as far as to say that the mechanisms of elections are not only methods through which societies may express their opinions but also indicators of how they use technology in general. Numerous elections throughout history have made use of emerging technologies in one way or another.

Today, ICT is a widespread, common phenomenon, so technology-based electoral procedures seem almost inevitable. However, some critics fear that the recent spreading of technology in elections endangers democracy, claiming that one cannot trust a fully electronic voting system (see, e.g., Jefferson et al. 2004b; Rubin 2006; Wijvertrouwenstemcomputersniet 2007). These authors insist that the questionable validity of numerous ballots during the United States presidential elections in 2000 due to hanging chads exemplifies why voting technology should be abandoned in favor of hand-counted paper ballots (for an in-depth analysis of the Florida 2000 experience, see Saltman 2006, 1-37).

Early in 2001, Märt Rask, at the time the Estonian Minister of Justice for the *Reformierakond* party, remained rather unimpressed by the recent US experience and thus announced a plan to introduce remote e-voting via the Internet (Internet voting) in Estonia for the 2003 parliamentary elections. This seemed a logical next step after e-banking and a paperless government, especially in a country that seemed to prefer electronic handling to traditional modes of conduct (on the overall genesis, see Drechsler and Madise 2004).

These diverging assessments show the clear division that has formed within the topic of e-voting. One seldom encounters a balanced approach that acknowledges the potential of using ICT while remaining cautious of the challenges it poses to the electoral processes.

These differing opinions also divide the ways that scholars follow to conduct their research. Their research is often motivated by either an effort to identify the methods that enable e-voting or an effort to identify the weaknesses of

[1] For the purpose of this thesis, e-voting encompasses all uses of ICT for either casting or counting votes. For an overview of various forms of e-voting, see **II**.

e-voting. Despite the multidisciplinary nature of the topic, some researchers focus only on identifying the legal issues or technical failures of e-voting (e.g. Karpen 2005; Jefferson et al. 2004a; Enguehard 2008; McGaley and McCarthy 2004), while others focus solely on technical or political issues (e.g. Fujioka, Okamoto and Ohta 1993; Ahlert 2003). However, there are some excellent exceptions, such as Alvarez and Hall (2004), Braun (2006), and Volkamer (2009), who try to include selected political, legal, technical and social perspectives while basing their research on practical experience whenever possible.

Nevertheless, the field lacks holistic research about e-voting that integrates these multidisciplinary perspectives with theoretical and practical approaches and gives an insight into the motivating and influencing factors for using voting technology in elections.

The goal of this dissertation is to attempt to fill this gap by looking at

1. how ICT affects democracy;
2. how to analyze the application of ICT in elections;
3. how the use of ICT in elections evolved; and
4. what the factors are that motivate election stakeholders to introduce ICT.

The research in this dissertation stems from more than nine years of extensive theoretical and practical research while working in Austria, Germany and Poland.[2] The study was finalized in Estonia, which served as the ideal setting for research on Internet voting.

The theoretical framework of this dissertation draws mainly on literature in algorithm research, electoral law and democracy theory, and was mainly undertaken during the first half of the research period. During the second half, the focus was put on practical work, especially in Austria, with additional insights gleaned through discussions and analyses of various forms of e-voting in Albania, Estonia, Finland, Germany, Norway, the Russian Federation, Switzerland, the United States and Venezuela.

The preliminary results of the dissertation were presented and discussed at international conferences and workshops in Albany (US), Athens (GR), Barcelona (ES), Berlin (DE), Bochum (DE), Bregenz (AT), Budapest (HU), Copenhagen (DK), Hagenberg (AT), Helsinki (FI), Innsbruck (AT), Krakow (PL), Krems (AT), London (UK), Madrid (ES), Manchester (UK), Mantua (IT),

[2] The views expressed in this thesis are those of the author and do not necessarily represent the views or methodology of, and should not be attributed to, the Organisation for Security and Co-operation in Europe (OSCE) and/or the Office for Democratic Institutions and Human Rights (ODIHR).

Moscow (RF), Oslo (NO), Paris (FR), Prague (PL), Salzburg (AT), Santiago (CL), Stellenbosch (ZA), Stockholm (SE), Strasbourg (FR), Tallinn (EE), The Hague (NL), Tirana (AL), Vadstena (SE), Varenna (IT), Vienna (AT), Waikoloa (US), Warsaw (PL) and Zaragoza (ES).

This thesis comprises original articles (see the list on page 4) that were co-authored by colleagues with different competencies and disciplines. Without this multidisciplinary collaboration, this research would not have been possible. Still, the author's own contribution to each article herein is considerable (**I** 50%, **II** 50%, **III** 40%, **IV** 25%, **V** 20%) and is mainly focused on ICT (**II, IV**), the information society (**I**), electronic democracy (**I**, **III**), and the policy implications of voting technology (**I**, **II**, **IV**; **V**) in Austria (**III**), the EU (**II**), and Council of Europe member states, as well as OSCE participating states (**IV**). The contribution of the articles to the four research topics is depicted below.

The first research topic – e-democracy – is analyzed in article **I**, and this analysis reveals that elected politicians use the same arguments to support technological innovation in the field of administrative reform that they use to hinder democratic reforms that would endanger their re-elections. Article **III** provides a case study of the ways that young citizens can contribute to policy making through means of ICT.

For the second topic – analyzing the application of ICT in elections – a conceptual model is developed, which was originally presented in articles **II**, **IV** and **VI**, discussing the legal, technical, political and social dimensions that affect organizing e-elections. Further, article **X** applies this framework and analyzes how the contexts in over thirty countries consisting of legal, technical, political and social dimensions (including the diffusion of ICT literacy) allow technological innovations such as e-voting in elections to develop.

The third topic – evolution of ICT in elections – is developed in articles **II** and **V**, which analyze how governments use technologies to conduct elections. The practical case studies collected in **VI** and **VIII** support this analysis. Furthermore, article **VII** discusses the transformation from paper-based to electronic remote voting channels. The overview provided herein is, however, to my best knowledge, the first balanced and comprehensive survey of the evolution of voting technology.

The last topic – motivating factors for e-voting – is elaborated in the following articles: The research in article **II** together with the case studies collected for articles **VI** and **VIII** explain the factors underlying e-voting's development. Article **I** describes politicians' motivation to use ICT for democratic processes. Finally, article **IX** shows one approach to how e-voting technologies could be assessed in election observation.

This introduction provides an overview of this research and is organized along the lines of these four topics. It starts out with the analysis of how the ICT transformation affects democracy including the barriers to this development (section 1). The following section (2) contains the presentation of a conceptual model to analyze the influence of the context on e-voting and how e-voting affects the electoral process itself.

Based on the research articles, the introduction expands on the evolution of voting-technology use from its early beginnings in ancient Athens to today's Internet voting (section 3). Such further analysis contributes to the overall output of this thesis in a way that would not have been possible if it only consisted of the research articles. The thesis concludes with the identification of motivators for the introduction of e-voting (section 4). Since the publication of the research articles, research topics have centered mainly on discussing how voting technologies can be made more accountable, including via methods of providing individual and universal end-to-end verifiability as well as through developing and improving the methodology for election observation of electronic voting (see Chaum 2010; Kripp, Volkamer and Grimm 2012).

1. The Coming of E-democracy

This introduction starts with the analysis of how the use of ICT can affect and challenge democracy and its underlying concepts, as well as detailing the recent developments in this area in the following section.

Given the historical development of government systems, it might come as a surprise that democracy is the most wide-spread form of governance today (UNDP 2002). Nevertheless, as Winston Churchill famously observed:

> Many forms of Government have been tried, and will be tried in this world of sin and woe. No one pretends that democracy is perfect or all-wise. Indeed, it has been said that democracy is the worst form of Government except all those other forms that have been tried from time to time; but there is the broad feeling in our country that the people should rule, continuously rule, and that public opinion, expressed by all constitutional means, should shape, guide, and control the actions of Ministers who are their servants and not their masters. (Churchill 1947)

Throughout time, however, democracy has not maintained a consistent format; instead, it has undergone drastic transformations. Its fundamental principle is arguably the recognition among members of a society that they are equally eligible to participate in decision making (Dahl 1998). The origins of the term "democracy" can be traced back to ancient Athens, where Cleisthenes reformed the constitution in 507 BC (Aristotle 1935; also Bleiken 1995). The republican practice in ancient Rome helped to establish this nascent form of government (Yakobson 1999).

Modern democracy evolved via the French Revolution and the United States' Declaration of Independence from the United Kingdom in the eighteenth century (Canfora 2007; Dunn 2005). These events marked a tipping point of democratic practice after which democracy spread around the globe. This development was not uniform, and several theories attempt to explain how it happened (amongst others, see Vanhanen 1984; Fukuyama 1992; Huntington 1993; Beyme 1994). Developments during the Arab Spring reaffirmed the trend that the number of countries ruled by democratic structures has been increasing since the Second World War and the end of communism.

In contrast to these developments, old and new democracies alike face challenges to their legitimacy in the forms of decreasing voter turnout and satisfaction (i.e. Ellis et al. 2006; Franklin 2004), a more pertinent disconnect between citizens and representatives (Coleman 2005), and the continuation of globalization (Coleman and Porter 2000; Kriesi et al. 2006).

In response to the increased availability of new technologies after the Second World War, several researchers discussed the technologies' democratic potential. Not long after these discussions began, philosopher Erich Fromm (1955) argued that using the technology for democratic processes would cure society from the lack of inclusive decision-making. The decline in voter participation in the 1980s added a sense of urgency to these discussions (Pintor and Gratschew 2002). Robert Dahl (1989) proposed the creation of a *minipopulus* consisting of 1,000 citizens who deliberate and decide on issues by using new technologies. He envisioned the deliberations occurring at any level of government, because the people of this *minipopulus* could use the technology to communicate from any location. Others have suggested virtual town-hall meetings that could have made feasible a greater number of personal forms of decision-making in large municipalities (Arterton 1987).

After the Internet earned considerable popularity at the end of the twentieth century, scholars' discussions of how to address changes in democracy gained new momentum. They expected the momentum from the revolutionary developments that started with online shopping (electronic commerce) and public-service deliveries over the Internet (electronic government) to continue changing democratic processes (for electronic democracy, see **III**). Researchers like Rheingold (1993) and Grossman (1995) foresaw the creation of a virtual agora, fully transforming nation-states into electronic republics. Some scholars, on the other hand, feared that the Internet could cause a digital divide in societies, because ICT access and ICT literacy are not readily available to everyone (Golding 1996; Haywood 1995).

Yet it was not the lack of inclusiveness that hindered e-democracy from developing as quickly as e-commerce or e-government had. Despite active involvement in e-government initiatives, many politicians did not support the

idea of an e-democracy, perhaps because they feared an ensuing loss of power (**I**). In the best case for them, they could use ICT to inform citizens of their intentions easily. Their reluctance is unfortunate because a balanced use of ICT could help a society to establish a continuous dialogue[3] between politicians and citizens who would debate how to address issues and what policy measures are in line with the will of the citizens. In the worst case, the full power of decision would lie with the citizens, who would decide all political decisions themselves by voting online (Aström 2001). This, of course, would mean that there would be no need for representatives anymore. Such an idea is diametrically opposed to Madison's description of representation, as he presented it in the Federalist papers. There, he stated that one can hold only the representatives accountable, not a majority of citizens (Hamilton, Madison and Jay 1788).

The theoretical considerations of ICT's potential to transform democracy followed different implementation patterns in the US and Europe. A grassroots website called *MoveOn.org* was the first US organization to recognize the Internet's role in politics, reaching out to voters during the presidential campaign of Howard Dean. A mere four years later, the Internet became the most important channel to finance the campaign of Barack Obama, largely due to the emergence of social networks like Facebook (Vargas 2008). Nevertheless, the federalist structure of the U.S. administration means that the non-government organizations, such as *AmericaSpeaks.org*, must organize the majority of e-platforms and tools that provide more interaction between representatives and citizens (D'Agostino, Schwester and Holzer 2006).

In Europe, as political parties have access to large public financing for their campaigns, the Internet has yet to gain considerable importance in campaigning. Most European governments envision ICT as providing e-petitioning platforms, such as those from the Scottish Parliament (Macintosh 2004) or the German *Bundestag* (Riehm et al. 2009). Otherwise, e-democracy has not received as much support from national governments as e-government.[4]

Thus, international organizations like the Council of Europe or the European Union could play an important role in fostering e-democracy's development. By following an expert group report that discussed several modernization ideas, including several ICT-based tools (Bozóki et al. 2004), the Council of Europe created an *ad-hoc* working group in 2005 to determine what electronic democracy could look like and to draft recommendations for its member states.

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[3] In recent years, "Liquid democracy information systems" that follow this scheme have been implemented by various European parties following the surprising success of the "pirate party" in Sweden. They want to provide more accountability for their work to the citizens. The pirate party of Berlin, Germany is a good example of their platform, which is available at http://www.liquidfeedback.org.

[4] One area has recently received more attention – online participatory budgeting, a concept well practiced in Brazil. For an overview, see Peixoto 2008.

This working group defined electronic democracy in the final document as "the support and enhancement of democracy, democratic institutions and democratic processes by means of ICT" (Council of Europe 2009). As part of this recommendation, the working group developed a set of thirty-three e-democracy tools and policies based on input from its member states (Krimmer, Kripp and Mendez 2009, compare the framework presented in **I** and the case study on e-consultation in **III**). In 2012, the European Union introduced the first transnational e-democracy instrument by launching its European Citizen Initiative (for background and practical guidance, see Kaufmann 2012).

The concept of democracy has changed quite considerably since its beginnings, and it continues to evolve. As such, the influence of ICT on democratic practices is not surprising. However, this influence is far smaller than in comparative transformational movements like e-government or e-commerce. Countries that wish to maximize e-democracy's potential need a more inclusive discourse and politicians who recognize that ICT can help them to overcome the apparent distance between themselves and the electorate whom they are representing. This inclusive discourse is especially important when one thinks about making use of ICT in elections, because elections comprise the core process of democracy.

2. The E-voting Mirabilis: A Conceptual Framework for the Analysis of ICT in Elections

The introduction of a new voting technology to an existing electoral process requires more than taking the paper-based process and making it e-enabled. Developers must also change the whole back-office process and reorganize the whole business process. As in e-government, supporting the complexity of e-voting requires an expansion of thinking. Technological progress and developments in the field of e-voting are increasing over time, and so are abilities of application of this technology. However, the multidisciplinary nature of elections presents a natural challenge. This section therefore presents a conceptual model that helps identify the areas that influence and are affected by the application of ICT in elections.

Interestingly, the same voting technology quite often works in one environment but not in another. The question therefore is, which fields influence and are affected by e-voting?

First, it is necessary to integrate manifold questions arising from several disciplines, which researchers must answer according to the context in which the election takes place, making each solution unique (Svensson and Leenes 2003).

Nevertheless, one can identify some main components reoccurring in the deployment of e-voting technology, and these can be best described in a conceptual model. In addition to preparing administrators for the actual use of the technology, such models also help researchers to understand and assess the use of ICT in elections before deployment. Conceptual frameworks are especially beneficial for election observers, who must pay close(r) attention to the context in which an e-voting technology is used than they must do with traditional voting procedures if they wish to assess the former properly (**IX**, OSCE/ODIHR 2008, 2012b).

The conceptual framework, as developed in articles **II**, **IV**, **VI** and **X**, consists of four main macro dimensions – Technology, Law, Politics and Society – that explain the areas that influence e-voting deployment. The model also includes a micro dimension of the application of voting technology to the electoral process itself, which covers the areas that are influenced by e-voting. It also includes the stakeholders of an e-enabled electoral process, as described in the previous chapter. Finally, it shows clearly the usefulness of selecting a multidisciplinary approach when applying and analyzing e-voting technologies. The following figure gives a graphical representation of the conceptual framework. The framework, which is essentially a mirabilis flower, has four petals that represent the four macro dimensions influencing the e-enabled electoral process.

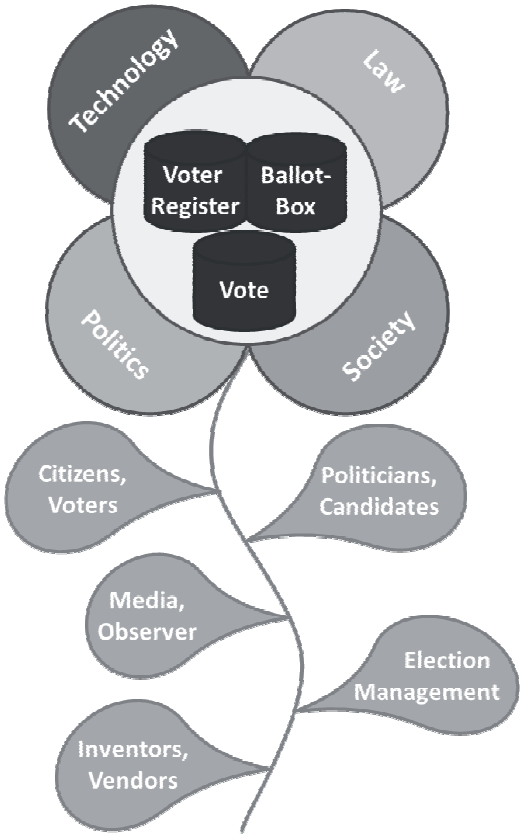

Figure 1: Conceptual Framework of "The E-voting Mirabilis" (further developed from II, IV, VI and X)

As described above, the conceptual framework is supported by the five stakeholder groups that help to apply ICT to the electoral process:

1. Voters, who are using the system to cast a vote;
2. Politicians, especially candidates, who run to be elected through the system;
3. Election managers who administer the election and ensure the proper functioning of the system;
4. Vendors, especially inventors, who designed, developed, and provided the system; and
5. Media representatives and election observers who monitor and report about the use of the system.

The first area is the technological dimension, for which researchers should consider how an e-voting technology can make use of the existing infrastructure (e.g. equipment in polling stations, central voter registers, election-management systems, ID documents and digital counterparts). This dimension includes the

option of a new form of identification, which the voter must provide when no proper identification mechanism is available. Second, it is important to determine how many voters are actually able to use the Internet or how many voters possess capabilities for digital signatures. For examples of which infrastructural issues are important in the technological dimensions see Braun, Prosser and Krimmer 2003.

Second, the legal dimension regulates how the electoral code can be changed in order to allow votes cast by electronic means and to provide necessary accountability to the voter, as an electoral code is often one of the first sources of information that a voter consults. It should provide the voter with the ability to see how his/her personal data is being processed. The documentation should also include the principle of proportionality when handling personal data, and it should serve as a guiding indicator. In other words, the use of ICT in elections should add value to the groups affected (Council of Europe 1981). In addition, any e-voting technology should provide the same possibilities as paper-based voting technologies (Heindl, Prosser and Krimmer 2003).

The third area is the political domain, where the question remains of what effect the introduction of e-voting will have. Possible effects include enabling individuals to participate who otherwise could/would not have, providing a trustworthy election outcome, and requiring the election administration's credibility and accountability during the process. It also includes the question of whether the system and the process meet the legitimacy criteria as set forth by Luhmann (1983) by providing enough possibilities for audits, evaluation, certification, as well as checks and balances. Another aspect is the overall political discussion of the topic. Does the public see the given technology as a useful tool for democracy, and if so, does the technology encourage higher quality voting, or does it encourage quicker and rash decisions? Alternatively, does it merely result in a quick democracy, as described by Aström (2001)?

The final dimension is the social domain, in which the citizens' trust is essential. Do the voters understand the e-voting technology enough (i.e. through voter education and training efforts) to understand the technical properties of the system and thus trust them? In addition, are the voters capable of using the system without trouble (EU Election Observation Mission to Venezuela 2006)? This component of IT-literacy might cause a technically perfect system to fail completely when the voters are not able to cast their votes as they intend to cast them because of difficult voter interfaces or misleading ballot sheets.

These four contextual factors then influence the implementation on the micro level, and thus the electoral components (ballot, ballot-box, and voter register) and the electoral process itself. Today, legal norms such as, i.a., the International Covenant of Civic and Political Rights (UNHCR 1966) or the 1990 Copenhagen document (OSCE 1990) best describe what the current understanding of an electoral process entails.

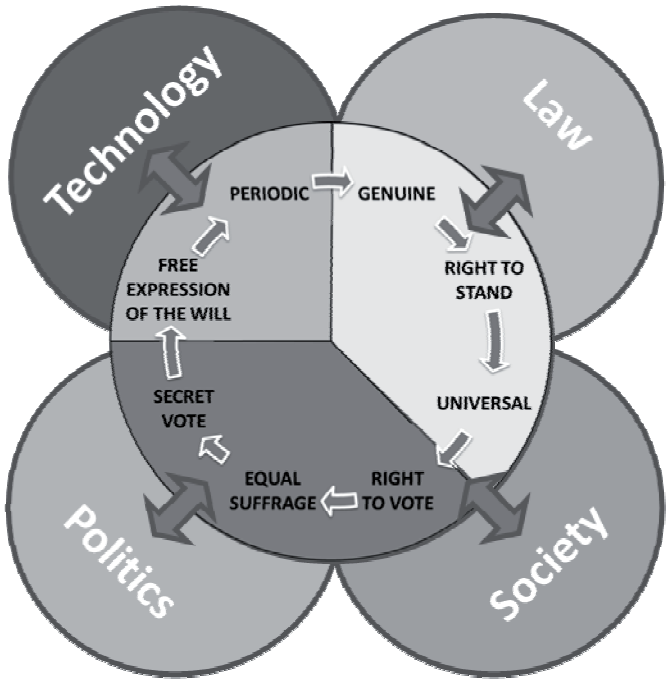

Figure 2: "The E-voting Mirabilis" Conceptual Framework with Integrated Electoral Process

Applying ICT to such processes comes with several crucial questions, e.g. the problem of how a system can guarantee fundamental principles is central. In controlled environments, poll workers check the eligibility of voters against the voter register, and the workers also use dedicated machines to record the cast votes in an electronic ballot-box. In uncontrolled environments, checking eligibility is a bit more complicated, because the workers must unequivocally determine the voter's identity while preserving the voter's anonymity (**II**, **V**, **IX**, Kofler, Krimmer and Prosser 2003).

Other considerations include assuring that the system does what it is supposed to do (Volkamer 2009; Barrat 2008) and allowing the general public to check the validity of results produced by e-voting technologies. The latter consideration led to the major question that gained momentum after the Florida 2000 experience and the German ruling (Federal Constitutional Court 2009): How can voters verify whether their votes have been counted as they intended? This concern created a new area of research in end-to-end verifiability (see, amongst others, Chaum et al. 2008; Rivest and Smith 2007), where only limited practical experience exists (OSCE/ODIHR 2012a). This remains a new challenge for the field, yet the promising stream of inquiry could enhance regular paper-based elections.

This conceptual model shows the four areas (technology, law, politics, and society) that influence e-voting systems as well as the components of an electoral process that are influenced by the use of ICT for voting processes. The e-voting mirabilis conceptual model is also able to help foster the development of e-voting systems in several ways, by helping to (i) reveal why certain systems are successful and why others are not; (ii) identify areas that require adaptation when transferring knowledge from one project to another; (iii) enable exchange between projects, because it makes the developers aware of differences; (iv) document and evaluate projects, an issue identified early on (Buchsbaum 2004); and (v) provide a comprehensive overview of a given implementation.

3. The Use of Technology in Elections: The Evolution of E-voting

Common to the legal norms, describing what constitutes a "democratic election" (for background in the genesis of global and European norms, see Lindblad and Suksi 2005), is the right of every citizen to participate in genuine periodic elections through universal and equal suffrage and the right to secret ballots. Nowadays, most elections around the world use ICT in elections to some degree, at least to summarize and aggregate the votes. This electronic adaptation is the result of a long period of evolution during which not only the procedures but also the technological means for casting votes changed considerably.

This section analyzes the development of voting technologies, from the formalization of voting procedures, via first mechanical efforts in order to conclude with the current status of electronic voting in polling stations and via the Internet.

Formalized Voting Procedures

The first recorded voting procedures occurred in meetings held in face-to-face societies (Laslett 1970). The aim of such meetings was to reach *homomonia*, a state that would allow the leaders to know their decisions would be backed by their citizens. They asked assemblies (which at the time included only men) for approval or disapproval of their decisions, especially when considering whether to go to war (Staveley 1972). This acclamation vote proceeded either through raising the voice or clapping swords, a procedure documented elsewhere in the Homeric institutions of early Greece or the Viking's assembly, known as *Thing* (Jóhannesson 1974).

When clear, uniform decisions were not possible, simple voting procedures were used to settle disputes (Held 2006). In ancient Sparta, the *apella* assembly established a procedure to try to measure the loudness of voices and thereby the

strength of the assembly's preference for an alternative (Flaig 1993). While Aristotle called this a childish voting procedure (Aristotle 1944, Book II, Chapter 9), this early attempt to count and aggregate votes can be considered one of the first voting procedures (Schwartzberg 2010).

The majority of early voting procedures included public voting. In ancient Athens, citizens either divided into different places according to their points of view (also called division) or indicated their preferences through show of hands. In ancient Rome, voters had to come forward to *rogatores* to indicate their votes, which were in turn added to the tabulated results (Staveley 1972). A similar method, called *viva voce*, was also used in Britain and the United States before the introduction of written ballots in the nineteenth century (Buchstein 2000a).

In Switzerland, public voting is still popular today in the *Landsgemeinde* (Möckli 1987), where citizens discuss and decide upon important local decisions. In the Swiss canton of Appenzell-Innerrhoden, men can hold up a sword to cast a vote (since 1991, women can also vote, but only by holding up their voting card), and the majority is decided by their *Landsammann* (for a narrative on the introduction of women's suffrage in Appenzell-Innerrhoden, see Hesse 2008).

When difficult decisions had to be made (e.g. court decisions or the decisions to ban citizens), casting votes in secret was an accepted alternative voting method in ancient Athens, Rome and the city state of Venice, despite being heavily debated (e.g. Buchstein 2000b; Thiele 2008; Braun 2006). In contrast to voting in public, voting in secrecy requires technology. The most basic forms of technology for voting in secrecy are voting tokens (*psephos*), which voters placed in urns or other vessels. Marbles, stones, and white or black beans are known to have been used as tokens (Yakobson 1999). The process of *ostracism* in ancient Athens made one of the most famous uses of ballots. The citizens of Athens wrote the name of a fellow citizen on a piece of clay. If one name appeared more than 6,000 times, then the citizen named was banned from the city for ten years (Hansen 1987). Athenians also used olive leaves as ballots. A special form of ballot used in ancient Rome was the wax tablet. These tablets offered two options, one on each side of the tablet, and the voter erased the option for which he did not want to cast his vote. Romans also used papyrus as ballots on rare occasions (Staveley 1972). Besides using a show of hands, the Venetian Republic also used voting tokens in a few of their procedures (Wolfson 1899). They called them *ballota*, which is likely the origin of the word ballot. These tokens comprised one part of the complex, multiple-step Venetian voting procedure. The *ballota* complemented the measures to control the flow of communication in the state and thereby limit the influence of powerful citizens (Drechsler 2002).

In the nineteenth century, voting processes gradually became more formalized (Thiele 2008). More and more voting procedures introduced secret voting by paper ballots (for an overview, see Schäffle 1865). However, many complaints of electoral fraud persisted, because very few formal criteria existed for ballots until the development of the Australian ballot (for an overview of its history, see McKenna 2002). This ballot provided the voter with all of the choices on one ballot, with the ballot's design equally representing each option and giving no preference to one over the other. It greatly contributed to the stabilization of the voting process in the US (Buchstein 2000a). Today the Australian ballot is the most commonly used voting method for secret vote casting around the world.

Mechanical Voting Machines

In England, the beginning of the nineteenth century saw increasingly active debate about electoral reform, including the proposition of abandoning viva voce voting in favor of paper ballots (for an overview of the history of the ballot in England, see Gross 1898). The major proponent of the paper ballot in parliament, George Grote, brought the issue to a vote several times. In 1836, his proposed bill included a voting machine (see Figure 3 below). The aim of the machine was to support the actual casting of votes, because it allowed the insertion of only one paper ballot at a time. Moreover, individuals using the machine could mark the ballot only by punching holes into it so that they would not unintentionally spoil the ballot and thus "vote according to their own inclination" (The Spectator 1837b). However, his proposal was not successful – in a vote in Parliament on 8 March 1837, the initiative failed 155 to 267 (The Spectator 1837c).

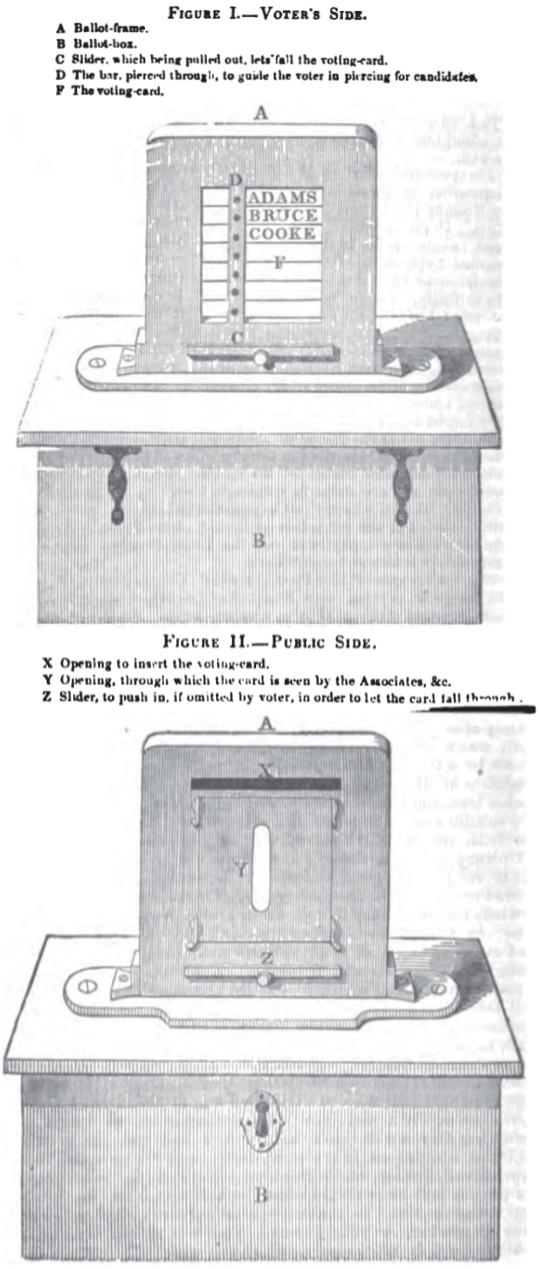

Figure 3: George Grote's Ballot-box (The Spectator 1837a)

Nevertheless, the proposal was further developed in the People's Charter of 1838. One of these developments was a machine invented by Benjamin Jolly that used balls instead of paper to cast. In addition, Jolly's machine would count votes (London Working Men's Association 1839; Helt and Fox 1848).

A Polish-born inventor, Jan Jozef Baranowski, proposed a mechanical voting machine that supported casting and counting of votes in polling stations based on the concept of the adding machines in Paris in 1849. His aim was to minimize human error during counting (Baranowksi 1849). William Chamberlain, Jr. presented a similar machine during the Great Exhibition in London (The Manchester Times 1851). At the end of the century, the monk Vito Leto proposed to the Italian king a mechanical voting device, which in the end was not implemented (Leto 1897; Zukerman 1925).

While the origins of the voting machine have been documented in Europe, it was further developed in the United States. The US presented an environment that was hospitable to inventors, so they developed many election-related innovations and patented them in the late nineteenth century. Such inventions included transparent ballot-boxes made out of glass or the machines by Morris Williams and Steuben Bacon that serialized paper ballots in order to prevent electoral fraud (Jones 2009). Jacob H. Myers' pull-lever machine (Myers 1889) was the first to be used in a legally binding election in Lockport in 1892 (Zukerman 1925). Such machines were widely used in the US for over 100 years (Arnold 1999) mainly so that the officials could count the votes quickly and accurately. They remained in use in New York State until 2009 (Chen 2010). Criticism faded soon after the first successful uses of the pull-lever machines (Zukerman 1927). Despite the simplistic design of this machine, the debates surrounding it followed patterns similar to the ones on Internet voting (Saltman 2006):

> Presumably the voting machine does require an act of faith on the part of the voter in a mechanical contrivance whose workings he cannot see. No more so, however, than is required in the case of the automobile in which he drives up to the polls. (Zukerman 1925)

After the Second World War, the US experience of using mechanical machines to cast and count votes made continental Europe rediscover its interest in this technology. Following the world exhibition in Liège in 1930, the German company *Maschinenfabrik Eller* worked with the Committee for Election-related Issues of the Association of German City Statisticians to design and manufacture ten mechanical voting machines. These machines were used in municipal elections in 1961 in the cities of Krefeld, Oberhausen, Dortmund, Duisburg and Düsseldorf. All participating municipalities considered these two machines a success, because they reduced the amount of administrative work compared to the polling stations that used traditional paper ballots (Amt für Statistik und Wahlen der Stadt Dortmund 1961). In the years to follow, several other mechanical machines were developed, some of which were used even in the new millennium (for a taxative list of approved voting machines, see Schreiber 2009).

In the Netherlands, similar thoughts prevailed. They were especially interested in the machines, because the machines made spoiling the ballots impossible. However, a test run of American pull-lever machines conducted in thirteen municipalities during the regional elections in 1966 was apparently very chaotic. A higher number of blank votes was registered, and the machines were considered unsuitable for the Dutch context, so the Netherlands decided to develop its own voting technology (Hermans and van Twist 2007).

Electr(on)ic Voting Machines

Since the first voting machines appeared, electrical engineering developed rapidly. Around the world, inventors approached their respective parliaments to suggest methods of recording votes electrically. The same year that Baranowski proposed his mechanical voting machine for polling stations, Martin de Brettes approached the French Senate with a plan for a machine that would record votes in the parliament by using electricity. He called it *Appareil pour voter, indiquer, autographier et contrôler les votes* (de Brettes 1875). Other proposals came from Clérac and Guichenot in 1870, Jacquin in 1874, and a year later from Morin as well as Laloy (Clérac 1875; Morin 1875; Laloy 1875). The senate did not make use of any of these proposals.

In Prussia, Werner von Siemens recommended his *Abstimmungs-Telegraphen* to the parliament in 1859 in order to replace the voting procedure of division (*Hammelsprung*). The system also included an option for secret voting (Siemens 1891). The parliament discussed this machine a second time in 1874, but with the same result: the parliament disapproved of the voting method, because it deemed the machine incompatible with the "pride of the German Reichstag" (Innsbrucker Nachrichten 1902).

In Austria-Hungary, the inventor Carl Albert Mayrhofer approached the government with an electro-magnetic voting machine in 1863 as well as a machine based on pneumatic principles in 1878. Both machines supported open and secret votes. In 1880, the Austrian-Hungarian Parliament discussed both Mayrhofer's system and an electric voting machine invented by Josef Schaller and Wilhelm Hayek, but it approved neither due to their lack of transparency compared to traditional voting (Mayrhofer 1880).

In 1869, Thomas A. Edison approached the American Congress with a proposal for his electro-graphic vote recorder, his first patented device, which would record the "yes" and "no" votes during a roll-call and therefore only allowed public voting (Edison 1869). His machine was similar to the patent by Henderson (1850). Even after an initial presentation, which clearly showed that the voting process would complete quicker than before, Congress did not see the benefit. Apparently, it would have changed the way the government

engaged in politics, and Filibustering and persuading members of the parliament was daily practice at that time (Edison Papers 2012).[5]

All e-voting inventions[6] in the nineteenth century shared the same fate: politicians found them interesting, but they did not consider them useful enough to pursue, as far as one can gather from the parliamentary debuts. The reasons that politicians put forward were manifold (see above), but can be summarized in the following assertion: the use of these e-voting devices would have most likely required changing the existing procedures with unknown outcome.

Only in the middle of the twentieth century did governments apply the first voting technology for polling stations that made use of electrical power. These machines counted paper ballots. The city of Los Angeles contracted a private company to develop a machine that could count the ballots of its growing population automatically. In 1959, the Norden Division of United Aircrafts began developing the optical mark-sense scanner for counting ballots in a central location. In this system, voters mark areas of the ballot with a pencil, and these ballots are then scanned at a central location (Arnold 1999).[7]

Joseph Harris is the notable author of the 1934 study of the US election administration system, and he identified many issues in the US voting system that remain problematic today (Harris 1934). In 1965, Harris received a patent for Votomatic, a punch-card system for voting that he based on the IBM Portapunch system (Harris 1965). For this apparatus, the ballot is a card, and the voters punch holes at pre-defined positions to indicate their choices. The cards are then tallied by a computer at a centralized location (Jones and Simons 2012). Some 1,200 punch-card systems were also used in sixty municipalities in the Netherlands from the 1970s until the late 1980s (Hermans and van Twist 2007; Leyenaar 2010).

In 1974, the first direct-recording electronic (DRE) voting machine was invented in the United States (McKay et al. 1974), and it was used in a legally binding election (Jones and Simons 2012). This machine allows voting on Election Day as well as in advance via polling stations. Voters would push a button next to a candidate. Newer machines nowadays include a touch screen displaying the ballot. Such machines were rapidly deployed after the Help America Vote Act, enacted after the Florida 2000 experience, in order to support vision-impaired voters by allowing them to cast their votes independently (HAVA 2002).

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5 However, about a century later Congress decided to install an electronic system in 1970, which was first used three years later. See Ryan 1972, Straus 2008.

6 For an overview of early German and French proposals of e-voting machines, see Zetsche 1881.

7 Such systems are still used today to evaluate forms and academic exams; see, for example, Florida State University 2012.

DRE e-voting machines were also developed in Europe, South America and Asia. In the Netherlands, the company NEDAP developed its own device in 1989, which was used there until 2006 (Hermans and van Twist 2007). Belgium developed its own version of a DRE system that consisted of two components – a vote-casting computer that stored the vote on a magnetic card and a computer serving as an electronic ballot-box, where the voter would place the cast vote. It was in use across nearly half the country from 1994 onward (OSCE/ODIHR 2006). Brazil began to use e-voting machines in 1998 (Superior Electoral Court 2012), and India started to use them in 1999 (Indian Electoral Commission 2012; Sen 2011). Both countries now use the machines countrywide and claim that they deliver the voting results quicker due to the technology of e-voting. Kazakhstan also piloted e-voting machines developed in Belarus in 2004 (OSCE/ODIHR 2004), 2005 (OSCE/ODIHR 2005) and in 2007 (OSCE/ODIHR 2007b).

Remote and Internet Voting

With the growing mobility of voters, election administrations were forced to offer possibilities to participate when voters were not present in their home constituency on election day. Voters in the Swiss canton of St. Gallen are reported as having sent their ballots via mail as early as 1673 (Braun 2006). In the UK, military personnel residing abroad were given the possibility to vote by mail in 1918. In Germany, postal voting was introduced in 1957 by a constitutional court ruling that weighed the election principles of universal vote against the secret vote (Stainer-Hämmerle 2009). Common to most forms of postal voting is the double-envelope principle. The voter first seals the vote in an anonymous envelope and then places that envelope into a second envelope on which evidence of the voter's eligibility is contained. However, postal voting requires the voters to choose an appropriate place to cast their ballot, and the voters must also ensure that they vote in private. This flexibility raises the problems of voter coercion and vote buying (**VII**).

The idea of using electronic means to enable voters to participate outside polling stations came already during the Second World War. Buckminster Fuller had the idea of providing every American household with a voting device that would allow "democracy [to] finally come true" (Fuller 1963). In 1978, researchers Ted Becker and Christa Slaton conducted Televote projects, where they conducted votes with hundreds of participants despite using only the telephone (Slaton 1992).

Four years later, David Chaum presented the idea of blind signatures, which allows officials to validate the identity and authenticity of a voter and still keep a vote secret (Chaum 1982). This invention allowed implementing an integrated electronic election consisting of all steps in an election in a public network, including eligibility checks, vote casting and counting, thus introducing the most complex form of e-voting: Internet voting.

Many more technical protocols were invented in the following years (**V** and amongst others Fujioka, Okamoto and Ohta 1993; Schoenmakers 1999; Kofler, Krimmer and Prosser 2003), and in the new millennium, the first legally binding elections were held in Europe with the Student Parliament elections in Osnabrück in 2000 (Otten 2001) and in the United States for the Arizona Democratic primaries in 2000 (Solop 2004). The UK piloted various Internet voting technologies in local elections in 2002, 2003 and 2007 with limited success (Pratchett and Wingfield 2004; Electoral Commission 2007). The Netherlands allowed their citizens living abroad to vote over the Internet in the 2004 European parliament elections and the 2006 parliamentary elections (OSCE/ODIHR 2007a). Similarly, Switzerland offered this option to their citizens residing abroad who were registered in one of four cantons (Basle, Geneva, Graubünden and St. Gallen) for the federal elections in 2011 (OSCE/ODIHR 2011a). Norway piloted a verifiable Internet voting system during their municipal elections in the Fall of 2011 (OSCE/ODIHR 2012a).

But of all nations developing Internet voting projects, it was Estonia, four years after starting the Internet voting project in 2001, that took the leading role as the first country in the world to enable all voters to cast their vote online in the 2005 municipal elections (Drechsler and Madise 2004; Maaten 2004; Madise and Martens 2006). To date, no other country has followed suit in a similar manner.

Recent Developments

In recent years, the discussions about the usefulness of electronic voting have intensified. In Germany (Federal Constitutional Court 2009), Kazakhstan (OSCE/ODIHR 2011b; Kassen 2010) and the Netherlands (OSCE/ODIHR 2007a; Loeber 2008), the use of this equipment ceased as a result of a political decision after a public hacking, lack of public support and a constitutional court ruling, respectively. Ireland had already bought NEDAP machines when it decided not to use them due to the intensity of the public debate at that time (see, e.g. McGaley 2009; McGaley and McCarthy 2004). Bulgaria (OSCE/ODIHR 2009) and Finland (Council of Europe 2008) ran pilot projects with varying degrees of success that were not continued (for an overview of lessons learnt from e-voting implementations see Caarls 2010).

Austria offered Internet voting once in the 2009 Federation of Students elections[8] (Krimmer, Ehringfeld and Traxl 2010). Due to the voters' lack of trust in the election administration (Schwarzer and Wallner 2009) and a constitutional court ruling (Österreichischer Verfassungsgerichtshof 2011), these efforts ceased, and parliamentary parties are currently focusing on a discussion of its general feasibility (Nagele 2012).

[8] The author of this thesis was contracted by the Austrian Federal Ministry of Science and Research as a consultant for this project.

Overview

Today, the various forms of voting technologies give election organizers a wide range of possibilities, such as optical scanners, e-voting machines or Internet voting procedures. For a structured overview of voting technologies, see Figure 4.

Voting Technology	How to Cast	How to Count	Voting in Public	Voting in Secret	Controlled Environment	Uncontrolled Environment
Acclamation	Raising Voice, Clapping Sword	-	☒	☐	☒	☐
Division	Body	Assess	☒	☐	☒	☐
Show-of-Hand	Hand, Sword	Assess	☒	☐	☒	☐
Rogatores, Viva Voce	Voice	Poll Books	☒	☐	☒	☐
Voting Token	Marbles, Beans, Stones	Urn, Vase	☐	☒	☒	☐
Unstructured Ballot	Palm Leaves, Clay, Paper	Urn, Vase, Ballot-box	☐	☒	☒	☐
Structured Ballot	Wax Tablets, Australian Ballot	Urn, Vase, Ballot-box	☒	☒	☒	☒
Postal Voting	Australian Ballot in Two Envelopes	Ballot-box	☒	☒	☐	☒
Mechanical Voting Machine	Pull-Lever	Register	☐	☒	☒	☐
Optical Scan, Punch Card	Paper Ballot, Card	Electronically Counted	☒	☒	☒	☐
DRE / Touch Screen E-Voting Machine	Push Button / Touch Screen	Electronically Counted	☒	☒	☒	☒
Internet Voting	Web-Browser	Electronically Counted	☒	☒	☒	☒

Figure 4: Overview of Voting Technologies (Adapted from II)

The application of these technologies is not uniform around the world. For a long time, the United States was the only country using mechanical or electronic voting technologies. America's lone status changed considerably in the last fifty years, and e-voting in its various forms is used in most places around the world and is being heavily discussed in Africa at present (see the map in Krimmer and Kripp 2009).

From the early beginning of elections, voting technology of various forms played an important role. Despite the manifold uses of mechanical and electronic voting technology as discussed above, the Australian (paper) ballot is still the quasi-standard for elections around the world. The use of mechanical voting machines has basically stopped after its last major user, the US state of New York, decided to switch to optical scanned ballots in 2009 (Chen 2010).

The use of electronic voting machines is still very much debated around the world. Despite its minority status, the use of Internet voting is definitely on the rise.[9]

Over 170 years have passed since the first thoughts about mechanical voting machines appeared, and contemporary knowledge and technology shaped this evolution (**II**). Also, the arguments over why certain types of technology should be pursued are very similar. In the following section, these will be further analyzed.

4. Motivating Factors for E-voting

As mentioned before, the election processes made use of new voting technologies depending on knowledge and availability. The motives for considering new forms of technology for casting and counting votes were manifold and will be discussed in more detail in this section.

The first motivating factor behind these discussions was to enable secret voting. Later, those in charge of determining the process of elections – election administrators – tried to devise ways to conduct elections in the best way available to them. Therefore, their aim has been to limit the number of unintentionally spoilt ballots due to human error (The Spectator 1837a; Churov 2010), to organize elections more effectively (and combatting fraud, see Saltman 2006), and to count the votes quicker and more accurately (Arnold 1999). They were supported by inventors who proposed technological advancements during phases of electoral reform (Jones and Hall 2006) and were interested in selling their patents and machines.

Notably, advanced technology can enable handicapped and vision-impaired voters to cast votes independently of a third party's help (HAVA 2002). Similarly, average voters might benefit from IT support that would help them to cast their votes. In addition, voters living outside a country's territory must e-vote over the Internet if they wish to overcome distance (Auslandsschweizer-Organisation [ASO] 2012). Last but not least, politicians can benefit from a first mover advantage and the appearance of embracing modern technologies (Drechsler and Madise 2004). They are also concerned about how the electorate will change and who might benefit from these changes (**I**). Other arguments include reducing the polling costs in the long run, maintaining or raising the voter turn-out, and establishing trust in the election administration (**II**, as well as ACE Project 2005; Zukerman 1925; EU Election Observation Mission to Venezuela 2006; Council of Europe 2004).

[9] For an overview of these developments, see **VI**, **VIII**, Kersting and Baldersheim 2004, Trechsel and Mendez 2005, Krimmer and Grimm 2008, Chaum 2010, Alvarez and Hall 2010, Krimmer and Grimm 2010.

Therefore, all forms of e-voting technologies (see previous chapter) affect the three main stakeholder groups involved in elections: (i) voters, (ii) election administrators and (iii) politicians. Moreover, they introduce a fourth category, (iv) the vendor. The figure below displays a compilation of motivating factors, which it attributes to their respective stakeholder groups.

Driver / Motivation	Administrator	Voter	Politician	Inventor (Vendor)
Appearance of embracing modern technologies			☒	
Cast votes independent of third persons' help		☒		
Changes in electorate result in different chances of being elected			☒	
Combat fraud	☒			
Count the votes more accurately and quicker	☒			
Establish trust in the election administration	☒			
First mover advantage			☒	
Maintain (raise) the voter turn-out	☒			
Organize elections more effectively	☒			
Participate in elections despite living outside a country's territory		☒		
Propose / advice on technological advancements				☒
Reduce the polling costs in the long run	☒			
Reduce unintentionally spoilt ballots due to human error	☒			
Sell voting technology				☒

Figure 5: Motivating Factors of Stakeholders for the Introduction of ICT to Elections (Own Compilation)

However, the use of ICT in elections results in challenges in addition to the positive effects for anyone involved in elections. Voters also have to spend more time understanding the broader process, and they might fear that voting technology makes it easier for administrators to rig an election. Therefore, administrators have to cope with an increased need for staff training. Finally, yet importantly, politicians may fear losing vote shares when the electorate changes due to new ways of voting, and they may hinder the decision-making process for this reason (**I**).

For another group of election stakeholders, which comprises the media and election observers, the use of e-voting is also posing more difficulties, because this group plays a relatively passive role in the election process. They believe the voters share their struggle to understanding e-voting technologies. Due to the inherent nature of these technologies, it is not possible for one to "see" the actual process of recording a vote with a human eye; one can touch and feel paper but cannot do so with electronic bits and bytes (Lenarčič 2010)[10], which is why assessing e-voting technologies is quite challenging.

The use of ICT in elections has manifold motivations, as shown in this chapter; most of them can be explained by the interests of each participating stakeholder. Although the introduction and promotion of a voting technology may not seem overwhelmingly difficult, implementing the transformation requires a lot of planning and knowledge about how the system can be best implemented in a given setting. The next chapter will analyze the context that influences the application of such new voting technology in an election as well as how it affects the election itself.

5. Conclusion

The application of information and communication technology to the electoral process is one of the most contended areas of the transformation from paper-based to electronically supported processes. When asked about the nature of this challenge, most people would answer that the question is not if e-voting will be used in the future, but rather when it is going to be used.

This thesis was centered on the core questions of

1. how ICT affects democracy;
2. how to analyze the application of ICT in elections;
3. how the use of ICT in elections evolved; and
4. what the factors are that motivate election stakeholders to introduce ICT.

The contribution to the literature on the topic can be summarized as follows:

First, this transformation process offers and enables more and different social interaction possibilities from very remote places and with people whom we hardly know. As such, it will naturally affect the way a democratic system works and will challenge existing paradigms, such as the concept of representation. The use of ICT in elections will provide for more possibilities to participate and will ideally be used in a context of constant dialogue between representatives and voters.

[10] **IX** presents a proposal regarding how election observers could assess ICT use in elections.

Second, the use of voting technologies is in no way easy. Discussions tend to lose focus due to the complexity and interdisciplinary nature of the topic. This inherent complexity can only be addressed with a conceptual model, such as the e-voting mirabilis that describes the influence factors of technology, law, politics and society and that describes the electoral process that is affected by e-voting. Only through such conceptualizations could developers make the discussions around e-voting more transparent and evident to a wider audience.

Third, the development that voting technology has undergone since the appearance of the first concepts of mechanical voting machines some 170 years ago is remarkable. The technology was applied depending on knowledge and availability. In the earliest elections, voting technologies were quite diverse, but this diversity decreased with the appearance of the Australian ballot, which is still the most widely used voting technology today. Shortly after this type of paper ballot became a quasi-standard, the diversification started again. Most parts of the US began to use mechanical voting machines for many decades. After the Second World War, the use of electronic devices started with the electronic counting of mark-sense enabled ballots, which progressed to punch-cards and finally the DRE electronic voting machines.

Last but not least, whereas all of these technologies were more or less designed to reduce fraud and to enhance accuracy and speed, the last invention in the field of voting technology aimed for something completely different. Internet voting, in theory, enables the voters to participate from anywhere in nearly no time at all in the election process of their choice. This technology also comes with the promise to enable more voters to cast their vote and thereby raise the turnout.

The realization of these promises could support the important goal of providing the politicians and representatives with the possibility to appear modern by endorsing a new voting technology for the core process of democracy. Estonia may easily be the best example of this political move.

Overall it can be said that the promises that developers are currently pairing with electronic voting are often too high, because “IT tools are not a panacea to solve existing problems in the elections field. … where there already is lack of trust in the electoral process, its digitalisation will not improve the situation; on the contrary, it may further diminish voter confidence” (Lenarčič 2010). Nevertheless, e-voting can offer additional functionalities to elections in areas where traditional technologies like paper ballots are limited by trying to raise and/or maintain voter turn-out, counting complicated and large-volume elections, supporting the handicapped, assisting vision-impaired voters, and facilitating remote voters’ participation in elections.

As history has shown, when a government follows a balanced and proportional approach that considers multiple dimensions and undertakes careful preparations, including deciding for a step-by-step approach, it can deploy voting technology that contributes to a better democracy.

6. Some Final Normative Considerations for the Future

In the past fourteen years, I have been discussing, researching and gaining experience with the application and assessment of e-voting around the world. During this time, I have often had déjà-vu moments, such as card drivers that did not work exactly as they had during a previous election, ballots that were declared invalid because of technical errors even though no legal framework in any country described grounds for this, communication patterns that led to controversies in other settings, and so on.

In response to these repeat situations, I wrote down some reminders for myself for the next time I would encounter a situation where I would have to make a decision according to my experience. I include below the points that I devised.

Pre-Requirements

1. We should not assume that a voting technology will build trust; instead, we should accept that the use of it requires trust.

2. We should acknowledge that every voting technology will become feasible when its time is right. We should not rush any new system.

3. We should not use voting technology just because we can.

Decision Making

4. We should always keep in mind what is best for the voter when considering voting technology.

5. We should conduct studies on voting technologies in order to determine their feasibility before making any attempt to implement the technologies.

6. We should design voting technology proportionally to its use.

7. We should have a selection process for choosing voting technology that is as transparent and as accountable as possible.

Implementation

8. We should implement voting technologies through a gradual approach, one step after another, by gaining experience in small pilots and by developing implementation slowly.

9. We should think of implementing voting technology only in the election after next in order to give it enough time.

10. We should acknowledge that the deployment of voting technology always goes slower than we expect.

Trust

11. We should do our best to explain voting technology to the laymen and give them the chance to experience it and learn to use it.

12. We should give the layman the tools to control voting technologies effectively without any need of prior knowledge.

13. We should give every stakeholder the chance to see and learn from all material that describes and constitutes the new voting technology without undue limitations.

Training

14. We should acknowledge that every additional voting technology raises the complexity of the election.

15. We should train all election administrators so that they are not dependent on technical support staff.

Testing

16. We should test every single component and interface of a given voting technology thoroughly and under real election experiences.

17. We should consider legal, technical, social and political aspects when assessing voting technology.

18. We should acknowledge that voting technology and the technological infrastructure it requires must be useful for and usable by the voter; otherwise, he/she will not use it.

Evaluation

19. We should always review lessons learned from every experience and document the experiences in the clearest possible way.

Discussion Culture

20. We should try to understand each other and accept differing views of the same issues, including the issue of e-voting.

Considering these lessons might help to achieve better results in upcoming trials of voting technologies.

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SUMMARY

The Evolution of E-voting: Why Voting Technology is Used and How It Affects Democracy

This dissertation's aim is to contribute to the research that addresses the challenge of ensuring effective participation in decision-making procedures using information and communication technologies (ICT) in twenty-first century democracies, which are assumed to be the best form of government available (UN 1945; EU 1993). The use of ICT in elections, also often called electronic voting (hereinafter: e-voting), touches upon core principles in the governance of the contemporary democratic state. One might go as far as to say that the mechanisms of elections are not only methods through which societies may express their opinions but also indicators of how they use technology in general. Numerous elections throughout history have made use of emerging technologies in one way or another.

Today, ICT is a widespread, common phenomenon, so technology-based electoral procedures seem almost inevitable.

Nevertheless, the field lacks holistic research about e-voting that integrates these multidisciplinary perspectives with theoretical and practical approaches, and gives an insight into the motivating and influencing factors for using voting technology in elections.

The research in this dissertation stems from more than nine years of extensive theoretical and practical research while working in Austria, Germany and Poland. The study was finalized in Estonia, which served as the ideal setting for research on Internet voting.

The theoretical framework of this dissertation draws mainly on literature in algorithm research, electoral law and democracy theory, and was mainly undertaken during the first half of the research period. During the second half, the focus was put on practical work especially in Austria, with additional insights gleaned through discussions and analyses of various forms of e-voting in Albania, Estonia, Finland, Germany, Norway, the Russian Federation, Switzerland, the United States and Venezuela.

The preliminary results of the dissertation were presented and discussed at international conferences and workshops in Albany (US), Athens (GR), Barcelona (ES), Berlin (DE), Bochum (DE), Bregenz (AT), Budapest (HU), Copenhagen (DK), Hagenberg (AT), Helsinki (FI), Innsbruck (AT), Krakow (PL), Krems (AT), London (UK), Madrid (ES), Manchester (UK), Mantua (IT), Moscow (RU), Oslo (NO), Paris (FR), Prague (CZ), Salzburg (AT), Santiago (CL), Stellenbosch (ZA), Strasbourg (FR), Tallinn (EE), The Hague (NL), Tirana (AL), Varenna (IT), Vienna (AT), Waikoloa (US), Warsaw (PL) and Zaragoza (ES).

This thesis comprises original articles that focus on ICT (**II, IV**), the information society (**I**), electronic democracy (**I**, **III**), and the policy implications of voting technology (**I**, **II**, **IV**; **V**) in Austria (**III**), the EU (**II**), and Council of Europe member states, as well as OSCE participating states (**IV**).

This dissertation contributes to four research topics, (1) how ICT affects democracy, (2) how to analyze the application of ICT in elections, (3) how the use of ICT in elections evolved; and (4) what the factors are that motivate stakeholders to introduce ICT, as follows:

First, this transformation process offers and enables more and different social-interaction possibilities from very remote places and with people whom we hardly know. As such, it will naturally affect the way a democratic system works and will challenge existing paradigms, such as the concept of representation. The use of ICT in elections will provide for more possibilities to participate and will ideally be used in a context of constant dialogue between representatives and voters.

Second, the use of voting technologies is in no way easy. Discussions tend to lose focus due to the complexity and interdisciplinary nature of the topic. This inherent complexity can only be addressed with a conceptual model, such as the e-voting mirabilis that describes the influence factors of technology, law, politics and society and that describes the electoral process that is affected by e-voting. Only through such conceptualizations can developers make the discussions around e-voting more transparent and evident to a wider audience.

Third, the development that voting technology has undergone since the appearance of the first concepts of mechanical voting machines some 170 years ago is remarkable. The technology was applied depending on knowledge and availability. In the earliest elections, voting technologies were quite diverse, but this diversity decreased with the appearance of the Australian ballot, which is still the most widely used voting technology today. Shortly after this type of paper ballot became a quasi-standard, the diversification started again. Most parts of the US began to use mechanical voting machines for many decades. After the Second World War, the use of electronic devices started with the electronic counting of mark-sense enabled ballots, which progressed to punch-cards and finally the DRE electronic voting machines.

Last but not least, whereas all of these technologies were more or less designed to reduce fraud and to enhance accuracy and speed, the last invention in the field of voting technology aimed for something completely different. Internet voting, in theory, enables the voters to participate from anywhere in nearly no time at all in the election process of their choice. This technology also comes with the promise to enable more voters to cast their vote and thereby raise the turnout.

The realization of these promises could support the important goal of providing the politicians and representatives with the possibility to appear modern by endorsing a new voting technology for the core process of democracy. Estonia may easily be the best example of this political move.

Overall it can be said that the promises that developers are currently pairing with electronic voting are often too high, because "IT tools are not a panacea to solve existing problems in the elections field. … where there already is lack of trust in the electoral process, its digitalisation will not improve the situation; on the contrary, it may further diminish voter confidence" (Lenarčič 2010). Nevertheless, e-voting can offer additional functionalities to elections in areas where traditional technologies like paper ballots are limited by trying to raise and/or maintain voter turn-out, counting complicated and large-volume elections, supporting the handicapped, assisting vision-impaired voters, and facilitating remote voters' participation in elections.

As history has shown, when a government follows a balanced and proportional approach that considers multiple dimensions and undertakes careful preparations, including deciding for a step-by-step approach, it can deploy voting technology that contributes to a better democracy.

ZUSAMMENFASSUNG

Die Entwicklung des E-Voting: Warum Wahltechnologie genutzt wird und wie sie sich auf die Demokratie auswirkt

Diese Dissertation soll einen Beitrag zur Forschung leisten, die sich mit der Herausforderung befasst, mithilfe von Informations- und Kommunikationstechnologien (*IKT*) eine effektive Beteiligung an Entscheidungsverfahren in Demokratien des 21. Jahrhunderts, die als beste verfügbare Regierungsform gelten (UN 1945; EU 1993), zu gewährleisten. Die Nutzung von IKT bei Wahlen, die häufig auch als elektronische Wahl (im Folgenden: E-Voting) bezeichnet wird, berührt Grundprinzipien der Führung eines modernen demokratischen Staates. Man könnte sogar so weit gehen zu behaupten, dass Wahlmechanismen nicht einfach nur ein Mittel für die Meinungsäußerung der Gesellschaft sind, sondern auch Indikatoren dafür, wie sie Technologie im Allgemeinen nutzt. Im Lauf der Geschichte wurden bei zahlreichen Wahlen auf unterschiedliche Weise neue Technologien genutzt.

Heute ist IKT ein weitverbreitetes, alltägliches Phänomen, wodurch technologiebasierte Wahlverfahren so gut wie unvermeidbar erscheinen.

Dennoch mangelt es auf diesem Gebiet an umfassender Forschung zu E-Voting, die diese fachübergreifenden Betrachtungen mit theoretischen und praktischen Ansätzen kombiniert und einen Einblick in die Faktoren, die die Nutzung von Abstimmungstechnologien bei Wahlen anregen und beeinflussen, liefert.

Die Erkenntnisse in dieser Dissertation wurden in mehr als neun Jahren ausführlicher theoretischer und praktischer Untersuchungen während der Tätigkeit in Österreich, Deutschland und Polen erlangt. Abgeschlossen wurde die Studie in Estland, welches ideale Bedingungen für die Forschung zur Stimmabgabe über das Internet bot.

Der theoretische Rahmen dieser Dissertation basiert hauptsächlich auf Literatur zur Algorithmenforschung, zum Wahlrecht und zur Demokratietheorie und wurde vor allem während der ersten Hälfte des Forschungszeitraums erarbeitet. Während der zweiten Hälfte stand die praktische Arbeit, insbesondere in Österreich, im Vordergrund. Zusätzliche Einblicke wurden dabei durch Diskussionen und Analysen zu verschiedenen Arten des E-Votings in Albanien, Deutschland, Estland, Finnland, Norwegen, Russland, der Schweiz, den USA und Venezuela zusammengetragen.

Präsentationen und Diskussionen vorläufiger Ergebnisse der Dissertation erfolgten bei internationalen Konferenzen und Seminaren in Albany (US), Athen (GR), Barcelona (ES), Berlin (DE), Bochum (DE), Bregenz (AT), Budapest (HU), Den Haag (NL), Hagenberg (AT), Helsinki (FI), Innsbruck (AT), Kopenhagen (DK), Krakau (PL), Krems (AT), London (UK), Madrid (ES), Manchester (UK), Mantua (IT), Moskau (RU), Oslo (NO), Paris (FR), Prag (CZ), Salzburg (AT), Santiago (CL), Saragossa (ES), Stellenbosch (ZA), Straßburg (FR), Tallinn (EE), Tirana (AL), Varenna (IT), Waikoloa (US), Warschau (PL), und Wien (AT).

Diese Arbeit setzt sich aus Originalbeiträgen zusammen, die sich mit IKT (**II, IV**), der Informationsgesellschaft (**I**), elektronischer Demokratie (**I**, **III**) und den Auswirkungen der Abstimmungstechnologie auf die Politik (**I**, **II**, **IV**; **V**) in Österreich (**III**), der EU (**II**) sowie in Mitgliedsstaaten des Europarats und Teilnehmerstaaten der OSZE (**IV**) befassen.

Diese Dissertation trägt zu den folgenden vier Forschungsgebieten bei: (1) wie sich IKT auf die Demokratie auswirken, (2) wie die Nutzung von IKT bei Wahlen analysiert werden sollte, (3) wie sich die Nutzung von IKT bei Wahlen entwickelt hat und (4) welche Faktoren Stakeholder zur Einführung von IKT bei Wahlen bewegen.

Erstens bietet und ermöglicht dieser Umstellungsprozess umfangreichere und andersartige soziale Interaktionsmöglichkeiten von entlegenen Orten aus und mit Menschen, die man kaum kennt. Insofern wird er die Funktionsweise eines demokratischen Systems natürlich beeinflussen und bestehende Paradigmen, z.B. das Konzept der Repräsentation, in Frage stellen. Die Nutzung von IKT bei Wahlen bietet zusätzliche Möglichkeiten der Partizipation und wird idealerweise im Zusammenhang mit einem fortwährenden Dialog zwischen Volksvertretern und Wählern erfolgen.

Zweitens ist die Nutzung von Abstimmungstechnologien keineswegs einfach. Diskussionen schweifen aufgrund der Komplexität und Interdisziplinarität des Themas schnell ab. Diese inhärente Komplexität lässt sich nur mithilfe eines konzeptuellen Modells bewältigen, wie der E-Voting Wunderblume, das zum einen die Einflussfaktoren von Technologie, Recht, Politik und Gesellschaft beschreibt und zum anderen das vom E-Voting betroffene Wahlverfahren. Nur durch derartige Konzeptualisierungen könnten Entwickler die Diskussionen um das E-Voting transparenter gestalten und einem breiteren Publikum zugänglich machen.

Drittens hat die Abstimmungstechnologie seit Auftreten der ersten Konzepte für mechanische Wahlgeräte vor rund 170 Jahren eine bemerkenswerte Entwicklung durchlaufen. Die Technik wurde je nach Kenntnisstand und Verfügbarkeit genutzt. Waren die Stimmabgabeverfahren bei den frühesten

Wahlen noch sehr unterschiedlich, setzte mit Einführung des „Australischen Stimmzettels“, der auch heute noch das am weitesten verbreitete Mittel zur Stimmabgabe ist, eine zunehmende Vereinheitlichung ein. Kurz nachdem diese Art des Wahlscheins aus Papier zum Quasi-Standard geworden war, entstand eine neue Vielfalt. In weiten Teilen der USA begann die Nutzung mechanischer Wahlgeräte, die viele Jahrzehnte lang anhielt. Nach dem Zweiten Weltkrieg setzte mit der elektronischen Zählung von Stimmzetteln mit optischer Zeichenerkennung die Verwendung elektronischer Geräte ein. Daraus entwickelten sich die Lochkarten und schließlich die DRE-Wahlcomputer.

Während all diese Technologien mehr oder weniger darauf ausgerichtet waren, Betrug zu bekämpfen und für mehr Genauigkeit und Schnelligkeit zu sorgen, hatte man bei der jüngsten Erfindung ein ganz anderes Ziel im Sinn. Theoretisch ermöglicht das Internet-Voting den Wählern die Teilnahme am Abstimmungsverfahren ihrer Wahl in kürzester Zeit von jedem Ort aus. Diese Technologie verspricht außerdem, mehr Wählern die Abgabe ihrer Stimme zu ermöglichen und damit die Wahlbeteiligung zu steigern.

Die Einhaltung dieser Versprechen könnte dem wichtigen Ziel, Politikern und Volksvertretern eine Möglichkeit zu bieten, sich durch die Befürwortung einer neuen Abstimmungstechnologie für den Kernprozess der Demokratie als modern zu präsentieren, zugutekommen. Estland ist vermutlich das beste Beispiel für diesen politischen Schachzug.

Zusammenfassend lässt sich sagen, dass die Versprechen, die die Entwickler derzeit im Zusammenhang mit der elektronischen Wahl geben, häufig zu groß sind. Dennoch kann das E-Voting in Regionen, wo traditionelle Verfahren wie Stimmzettel aus Papier nur eingeschränkt verfügbar sind, zusätzliche Vorteile bieten, etwa durch den Versuch, die Wahlbeteiligung zu steigern und/oder aufrechtzuerhalten, die Auszählung komplizierter, umfangreicher Wahlen, die Unterstützung körperlich oder sehbehinderter Wähler und die Erleichterung der Teilnahme für Wähler in entlegenen Gebieten.

Wie die Geschichte zeigt, kann eine Regierung, wenn sie einen ausgewogenen, verhältnismäßigen Ansatz wählt, der vielfältige Aspekte berücksichtigt und eine sorgfältige Vorbereitung beinhaltet – einschließlich der Erwägung einer schrittweisen Vorgehensweise – Wahltechnologien einführen, die zu einer besseren Demokratie beitragen.

KOKKUVÕTE

E-hääletamise evolutsioon: miks kasutatakse hääletamistehnoloogiat ja kuidas see mõjutab demokraatiat

Väitekirja eesmärk on anda panus uurimisvaldkonda, mis käsitleb kodanike osalemist otsustusprotsessis info- ja kommunikatsioonitehnoloogia (IKT) abil 21. sajandi demokraatia – eeldatavasti parima olemasoleva riigikorra (UN 1945; EU 1993) – tingimustes. Infotehnoloogia kasutamine valimistel, teisisõnu elektrooniline hääletamine (edaspidi: e-hääletamine), puudutab nüüdisaegse demokraatliku riigi valitsemise põhiolemust. Võiks isegi väita, et riigi valimiskorraldus ei kujuta endast pelgalt mehhanismi, mis võimaldab ühiskonnal oma arvamust avaldada, vaid annab ettekujutuse üldisest tehnoloogiakasutusest. Valimistel on läbi aegade kasutatud uudseid tehnoloogilisi lahendusi. Tänapäeval, kui IKT on saanud lahutamatuks osaks meie igapäevaelust, näivad tehnoloogiapõhised valimisprotseduurid pea vältimatud.

Siiski puudub valdkonnas siiani terviklik e-hääletamist käsitlev teadusuuring, mis seoks erinevaid multidistsiplinaarseid vaatenurki teoreetiliste ja praktiliste lähenemistega ning annaks seeläbi ettekujutuse nendest motiividest ja teguritest, mis mõjutavad hääletamistehnoloogiate kasutamist valimistel.

Käesolev väitekiri põhineb enam kui üheksa aasta pikkusel ulatuslikul teoreetilisel ja praktilisel uurimistööl Austrias, Saksamaal ja Poolas. Töö valmis lõplikult Eestis, mis on ideaalne koht internetihääletuse uurimiseks.

Väitekirja teoreetiline raamistik tugineb eelkõige valimissüsteemide, valimisseaduste ja demokraatiateooriate alasele kirjandusele; töö kirjandusega toimus valdavalt uurimisperioodi esimeses pooles. Uurimisperioodi teises pooles oli rõhk praktilisel tööl, seda eriti Austrias. Lisaks andsid uurimistööle palju juurde diskussioonid ja analüüsid e-hääletuse erinevatest kasutusviisidest Albaanias, Eestis, Soomes, Saksamaal, Norras, Vene Föderatsioonis, Šveitsis, Ameerika Ühendriikides ja Venetsueelas.

Väitekirja esialgseid tulemusi esitleti ja analüüsiti rahvusvahelistel konverentsidel ja seminaridel Albanys (US), Ateenas (GR), Barcelonas (ES), Berliinis (DE), Bregenzis (DE), Budapestis (HU), Kopenhaagenis (DK), Hagenbergis (AT), Helsinkis (FI), Innsbruckis (AT), Krakowis (PL), Kremsis (AT), Londonis (UK), Madriidis (ES), Mantuas (IT), Moskvas (RU), Oslos (NO), Pariisis (FR), Prahas (CZ), Salzburgis (AT), Santiagos (CL), Stellenbochis (ZA), Strasbourgis (FR), Tallinnas (EE), Haagis (NL), Tiranas (AL), Varennas (IT), Viinis (AT), Waikoloas (US), Varssavis (PL) ja Zaragozas (ES).

Väitekiri koosneb algupärastest artiklitest, mis keskenduvad IKT-le (**II**, **IV**), infoühiskonnale (**I**), elektroonilisele demokraatiale (**I**, **III**) ja hääletustehnoloogia poliitilistele aspektidele (**I, II, IV, V**) Austrias (**III**), Euroopa Liidus (**II**) ja Euroopa Nõukogu liikmesriikides, samuti OSCE osalisriikides (**IV**).

Väitekiri panustab nelja uurimisvaldkonda: (1) milline on IKT mõju demokraatiale; (2) kuidas analüüsida IKT rakendusi valimistel; (3) millised on olnud arengud IKT kasutamisel valimistel; (4) millised on mõjutegurid, mis motiveerivad sidusrühmi valimistel IKT lahendusi kasutama, tehes seda järgnevalt.

Esiteks, säärane muutuste protsess pakub enam võimalusi sotsiaalseks interaktsiooniks ka suurte vahemaade tagant ja inimestega, keda vaevalt tunneme. Nõnda mõjutab see loomulikult ka demokraatia toimemehhanisme ning esitab väljakutse kehtivatele paradigmadele, näiteks esindatuse kontseptsioonile. IKT kasutamine valimistel annab suurema osalemisvõimaluse ning ideaalvariandis toimib esindajate ja hääletajate vahelise pideva dialoogi kontekstina.

Teiseks, hääletamistehnoloogiate kasutamine ei ole kindlasti lihtsakoeline protsess. Sellekohased arutelud kipuvad kaotama fookust tulenevalt teema keerukusest ja interdistsiplinaarsusest. Siinkohal oleks abiks e-hääletuse kõikehõlmav kontseptuaalne mudel, mis koondaks ühte tehnoloogilised, õiguslikud, poliitilised ja ühiskondlikud mõjutegurid ja kirjeldaks ka seda, kuidas e-hääletamine valimisprotsessi mõjutab. Vaid säärase kontseptualiseerimise kaudu saavad e-hääletamise käsitlused selgemaks ja arusaadavamaks ka laiemale publikule.

Kolmandaks, alates esimestest mehaanilise hääletamise katsetustest pea 170 aastat tagasi on hääletamistehnoloogias toimunud märkimisväärne areng. Tehnoloogilisi lahendusi kasutati sõltuvalt oskustest ja võimalustest. Valimiste algaastatel kasutati väga erinevaid hääletamismeetodeid, kuid nende hulk vähenes oluliselt alates nn Austraalia hääletamistehnoloogia kasutuselevõtust, mis on tänase päevani kõige levinum hääletusviis. Kui valimised etteantud nimedega salajaste hääletussedelite abil olid kujunenud pea standardiks, hakkasid sinna kõrvale tekkima taas ka teistsugused lahendused. Pärast teist maailmasõda võeti elektroonilised abivahendid kasutusele esmalt häältelugemisel, seejärel elektrooniliselt töödeldavate hääletuskaartidena ja lõpuks hääletusmasinate näol.

Viimasena, kuid mitte vähemolulisena, pälvis uurimistöö kontekstis tähelepanu tõdemus, et kui kõik varasemad tehnoloogilised lahendused olid peaasjalikult suunatud valimispettuste vähendamisele ning protsessi täpsuse ja kiiruse suurendamisele, siis värskeim uuendus hääletamistehnoloogia vallas täidab hoopis teistsugust otstarvet. Teoreetiliselt võimaldab internetihääletus valijatel

osaleda mistahes valimistel, sõltumata nende asukohast ja ilma igasuguse ajakuluta. See hääletusviis võimaldab valimistel osalemise teha kättesaadavaks palju suuremale valijaskonnale ning tõsta seeläbi ka valimisosalust. Kui need võimalused realiseeruvad, toetab see omakorda teist olulist eesmärki – anda poliitikutele ja esindajatele võimalus luua endast uudse hääletusviisi eestkõnelejana nüüdisaegse demokraatia edendaja kuvand. Eesti on sellise poliitilise sammu üks paremaid näiteid.

Kokkuvõtteks võib öelda, et elektroonilise hääletussüsteemi väljatöötajate lubadused on tihti liiga ambitsioonikad, kuna "infotehnoloogia ei ole imerohi seniste valimistega seonduvate probleemide lahendamiseks. /…/ kui valimisprotsessis puudub usaldus, ei paranda olukorda ka digitaliseerimine – vastupidi, valijate usaldus võib veelgi langeda" (Lenarčič 2010). Sellegipoolest võib e-hääletamine täiendada valimiste funktsionaalsust valdkondades, kus traditsiooniliste hääletusviiside, nt pabersedelite, võimalused on piiratud: näiteks valimisosaluse taseme säilitamine ja suurendamine, häälte lugemine suuremahulistel ja keerulise valimissüsteemiga valimistel, puuetega inimeste erivajaduste arvestamine, nägemispuudega valijate toetamine ja eemalasuvate hääletajate osaluse võimaldamine.

Nagu ajalugu on näidanud, võib valitsus, kes järgib tasakaalustatud ja proportsionaalset lähenemist, mis võtab arvesse protsessi erinevaid aspekte, ning on teinud põhjalikke ettevalmistusi, mis hõlmavad ka protsessi samm-sammult läbimõtlemist, kasutada hääletamistehnoloogiat, mis aitab kaasa demokraatia edendamisele.

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PUBLICATIONS (Articles I – V)

Article I

Mahrer, Harald and **Robert Krimmer**. 2005. "Towards the Enhancement of e-Democracy: Identifying the Notion of the Middleman Paradox." *European Information Systems Journal* 15(1), 27-42. (1.1)

Developed economies are facing ever more challenges to forms of e-democracy that seek the electronic transformation of political systems. E-democracy forms a component of overall e-government initiatives that attempt to encourage adoption and diffusion of technology in order to enhance the delivery of government services and to broaden access. The implementation of e-democracy projects is undertaken at a much slower pace and with dramatically less support than the implementation of the so-called e-administration activities in the public sector. This paper investigates the halting evolution of e-democracy and clearly identifies politicians as an inhibiting factor.

Towards the enhancement of e-democracy: identifying the notion of the 'middleman paradox'

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Abstract. *The challenge towards e-democracy, through the electronic transformation of political systems, has become increasingly evident within developed economies. It is regarded as an approach for increased and better quality citizen participation in the democratic processes. E-democracy forms a component of overall e-government initiatives where technology adoption and diffusion, to enhance wider access to, and the delivery of, government services, are apparent. However, previous research demonstrates that very few e-democracy proposals survive the stage of formal political decision-making to become substantive e-government projects within national or international agendas. Furthermore, the implementation of e-democracy projects is undertaken at a much slower pace and with dramatically less support than the implementation of other, so-called e-administration, activities in the public sector.*

The research in this paper considers the notion of the 'middleman paradox', presenting theoretical and empirical evidence that further investigates the phenomenon associated with potential e-democracy improvements. Specifically, the paper adds a new dimension to existing theories on the hesitant evolution of e-democracy that clearly identifies politicians as an inhibiting factor. Proposals are made for an enhancement of these processes, and suggestions for further applicable research are demonstrated.

Keywords: e-government, e-administration, e-democracy, digital democracy

INTRODUCTION

As the awareness for e-government is increasing, governments and societies all around the globe are engaging with a digital future for the public sector. Government agencies are using technology to enhance the access to, and the delivery of, government services to citizens,

business partners and employees (Heeks, 2001). E-government is not only about changes in the area of public administration but also about changes in the area of public decision-making. Internal as well as external communications and operations are affected through the emerging and strategic use of information technology (IT) in the public sector (Grönlund, 2002).

Therefore, e-government is not only a term that refers to the transformation of governmental services, so-called e-administration, but also about the transformation of political systems, so-called e-democracy (Gisler, 2000; Schedler, 2000; Agren, 2001; Merz, 2001; Grönlund, 2002). Definitions of e-government vary but generally contain goals of more efficient operations, better quality of services and increased citizen participation in democratic processes (Grönlund, 2002). E-administration is directed to meet the needs and expectations of citizens. It is an attempt to optimize the internal processes of public administration, leading to a reduction of internal processing time and an enhancement of internal communications. Therefore, this administration, together with cost reduction and the identification of new outsourcing opportunities (Heeks, 2002; Mahrer, 2002), generates more flexibility and lower response times of administrative bodies (Osborne & Gaebler, 1992; Heeks, 2001). E-Democracy is generally regarded as a tool for abandoning the representative system for one with a more direct citizen engagement (Becker, 2001; Grönlund, 2001; Browning, 2002; Davis *et al.*, 2002). To achieve these overall goals, government officials are trying to develop adequate e-government strategies that will determine to a large extent the success or failure of the ensuing e-government projects.

These newly formulated e-government strategies are addressing a vast number of projects in the area of e-administration, and there is substantial empirical evidence about the success of the majority of these initiatives (United Nations, 2003). However, it is frequently questioned why the same strategies are only addressing e-democracy as a rhetorical promise (Coleman, 1999; Moore, 1999; Anttiroiko, 2001). Still, the claims about the benefits of e-democracy can be found within e-government strategies on the international and national level, but these claims are fundamentally lacking empirical evidence concerning the effects of proposed projects. Compared to the total amount of e-administration projects within different e-government initiatives, the amount of e-democracy projects is negligible (Wilhelm, 2000; Agren, 2001; Anttiroiko, 2001; Betz & Bargmann, 2003). As the United Nations Global e-government survey states quite clearly, 'The world's top 20 countries in the area of e-government, on average, are currently providing on-line opportunities for citizen participation that are seriously lacking in relevancy and usefulness, and are at only a third of the potential of what they could offer' (United Nations, 2003).

Consequently, the research in this paper attempts to add a new dimension to existing theories on the hesitant evolution of e-democracy – the 'middleman paradox'. The paper is organized as follows. First, we discuss the theoretical framework concerning the fields of political communication, e-government and e-democracy, and our research objectives. An exploratory research design is adopted, and we present the findings of our multiple case study. The cross-case analysis is followed by a discussion in which we relate our findings to theories of e-government and e-democracy evolution.

CONTEXTUAL BACKGROUND

Historically, the internet has been the subject of many discussions on how to influence the extension of democracy. There are frequently reported expectations to develop a virtual agora to involve citizens (Rheingold, 1993; Barber, 1998; Gilder, 2000). However, the reality remains that the internet appears to enlarge the inequalities of the digital divide within information-rich and information-poor environments (Haywood, 1995; Golding, 1996). Neutral analysis and opinions remark that so far the influence of the internet in politics has been limited to fund raising, and only in rare cases does it help organize grassroots support (Bimber, 2001; Leggewie & Bieber, 2001; Foot & Schneider, 2002). As the effects on different western democracies are still in their early stages, observers raise an ever increasing number of challenging questions concerning the impacts that the internet could have on the concept of democracy: Following the idea of deliberation (Fishkin, 1991; Ackerman & Fishkin, 2004; Van Aaken *et al.*, 2004), will democracy still need its experts (politicians) to balance society's different interests? Will we have more direct democracies than representative democracies? Will there be a broadening of the spectrum of the politically engaged population? Will there be a fragmentation of the sense of community and legitimacy that underpins central governments and central parliaments (Morris & Ogan, 1996; Nugent, 2001; Applbaum, 2002; Levin, 2002; Nye, 2002; Schlosberg & Dryzek, 2002; Thompson, 2002)? Analysts who study the internet and its impact on political processes seek to address these questions, but empirically grounded and theoretically satisfying insights remain elusive.

However, the literature on e-government often argues that e-democracy is founded on the idea of streamlining political communications and altering aspects of political decision-making in order to improve the effectiveness and efficiency of democracy (Hague & Loader, 1999; Schuler, 2001; Watson & Mundy, 2001; Browning, 2002; Gross, 2002; Mahrer & Brandtweiner, 2004). In Mahrer's society/media/politics (SMP) model for political communication, (Mahrer, 2003) e-government reports the transformation of the continuous cycle of political communication between various players within these three different spheres. According to the model, the cycle is based on four different stages of interaction:

1 public discussion of political ideas and issues;
2 formal decision-making;
3 implementation and execution of decisions; and
4 public elections.

Figure 1 shows the stakeholders within the SMP model for gathering information who are attempting to communicate with one another or even carrying out transactions for political communication. These interactions between different groups can also be defined as processes of information, feedback/consultation and participation (Watson & Mundy, 2001; Macintosh, 2004).

Combining these approaches enables research on e-democracy to be clustered within the e-government research portfolio. Figure 2 is a mapping of the areas of interaction with administration – including interaction with government and jurisdiction – (e-administration) and of

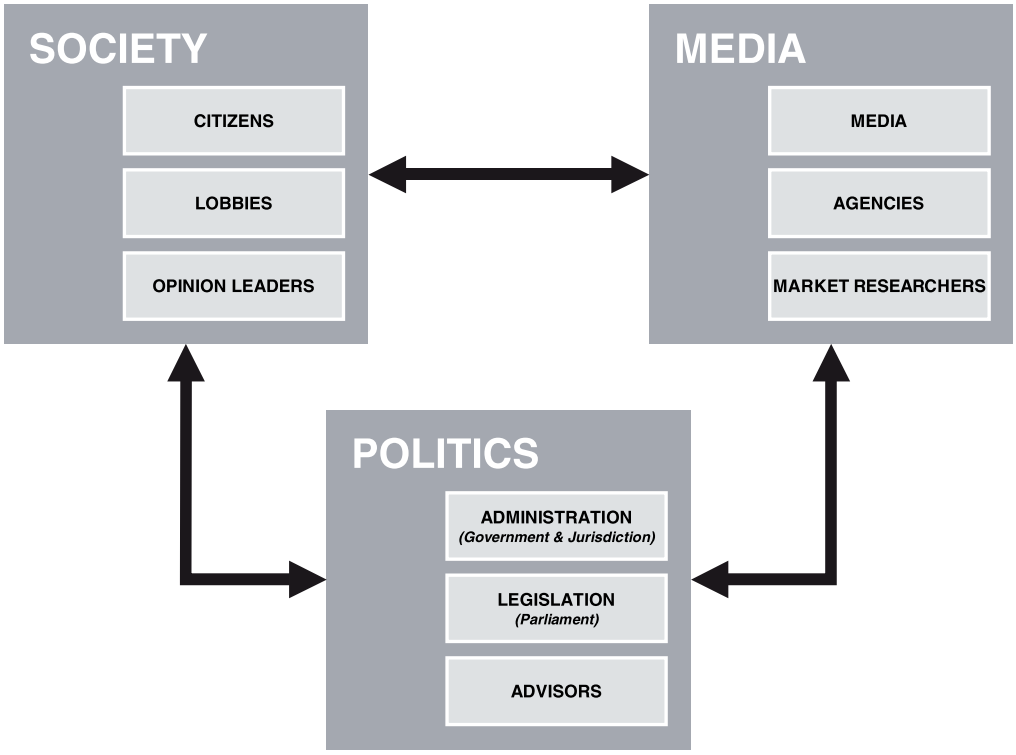

Figure 1. The players within the society/media/politics model.

interaction with legislation (e-democracy) within the SMP model. The 12 arrays characterize the complex procedural interplay between the systems of society, media and politics. The research portfolio also shows that e-democracy is not only about technology (and involves both so-called e-participation and e-voting) but also impacts every aspect of an organization involved. In addition, it captures the behaviour of the members of the society (citizens, lobbies and opinion leaders), the media (media, agencies and market researchers) when interacting with, and attitudes towards, government agencies and representatives.

Unfortunately, despite the substantial body of knowledge with regard to the evolution of the different applications of e-administration and e-democracy, described in the e-government research portfolio above, the reason why so few countries worldwide are utilizing the full potential of e-government as a tool is uncertain. In particular, why are so many countries not facing the challenge of involving the public in participatory and deliberative thought processes that could augment government's decision-making? Current research findings demonstrate that citizen participation remains patchy and uneven in all countries around the globe, with its full potential underutilized (United Nations, 2003). It is frequently argued that the vast majority of government IT spending is focused on the administrative processes, and it is also noted that

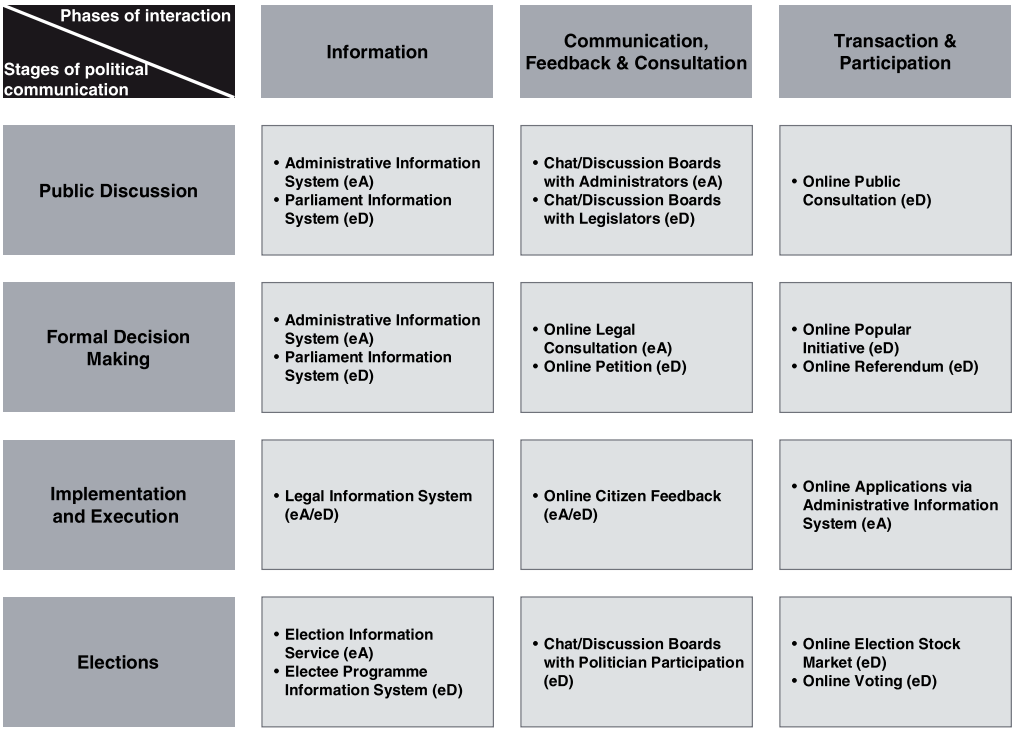

Figure 2. The e-government research portfolio. eD, e-democracy (interaction with legislation); eA, e-administration (interaction with government and jurisdiction).

the 'services first and democracy later' approach to e-government is a significant barrier to a balanced and successful e-government programme (Clift, 2002). A recently published report by the Organization of Economic Co-operation and Development on the promise and problems of e-democracy identified some of the major barriers to digital citizen engagement and identified five main challenges, using the citizen as a point of reference (Macintosh, 2003). These are: coping with the problem of scale; building capacity and active citizenship; ensuring coherence throughout the policy-making progress; evaluating the benefits and impacts of offering digital citizen engagement; and ensuring government commitment.

Related to our conceptual framework of the SMP model (Figure 1), the members of the spheres of the society and the media are enthusiastically calling for a more committed transformation of the political system towards active citizen participation within the democratic process (Mahrer *et al.*, 2003a, b). It is observed that different levels of support for, and commitment to, e-administration and e-democracy are offered by political decision makers. The research objectives within this paper therefore are to identify what could be hindering the improvement of the topology and the introduction of new vehicles for democratic practice based on existing e-government strategies. Realizing that newly implemented e-government

strategies were not addressing e-democracy at all, or were only addressing e-democracy as a rhetorical promise, we formulated our overall research question mainly relating to the members of the sphere of politics – as our point of reference – as described in the SMP model: Are politicians promoting the further evolution of e-democracy to a much lesser extent than they are the evolution of e-administration, and if so why?

RESEARCH METHODOLOGY AND DESIGN OF THE STUDY

Our research team decided that consistent with the focus of our research, an exploratory approach would be the most appropriate method of collecting data within the political system to provide insights to our research question. As the case study approach refers to an in-depth study or investigation of a contemporary phenomenon using multiple sources of evidence within its real-life context, we set up a multiple case study design (Figure 3) using a theoretical replication logic (Yin, 1994). By following this case research design we had the opportunity to engage in theory-building in an area in which there has been relatively little prior research

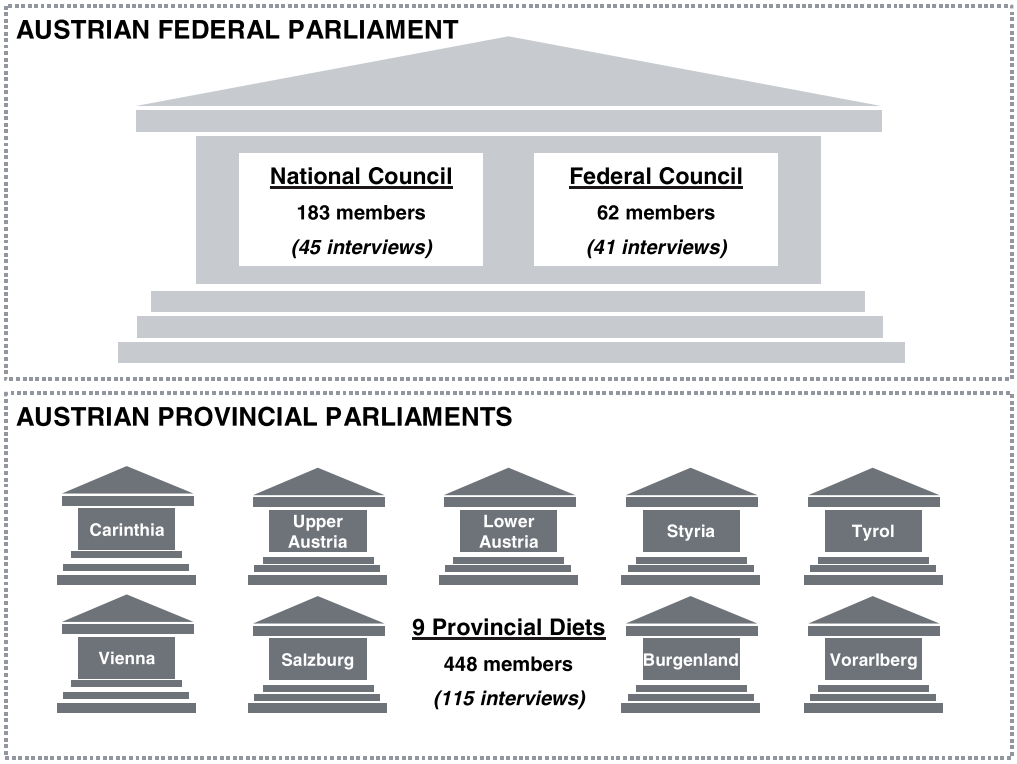

Figure 3. Multiple case study design.

(Benbasat *et al.*, 1987). We tried to begin as close as possible to the ideal of no theory under consideration and no hypotheses to test (Eisenhardt, 1989).

We selected cases that fell into two different categories: the first comprises the two chambers of the Austrian Parliament (National Council and Federal Council); the second comprises all nine Provincial Diets. We sought cases that differed on being active or passive in the Austrian discussion about e-democracy. We collected data using multiple methods, including documentation, archival records, protocols, minutes, reports, speeches, vision statements, white papers, strategy reports and interviews, as well as internal discussion papers of the different political parties.

Overall, 201 semistructured, open-ended interviews were administered as important sources of information to provide for focus, reliability and increased validity (Yin, 1994). We conducted these interviews with members of parliament of all government and opposition parties according to the SMP model of our research framework (Mahrer, 2003). The interviews with the relevant decision makers of the National Council (45) and Federal Council (41) and with members of the nine Provincial Diets: Vienna (28), Lower Austria (14), Upper Austria (12), Salzburg (9), Tyrol (10), Vorarlberg (7), Burgenland (8), Styria (16) and Carinthia (11) were used to allow participants to give their personal experience and interpretation of the ongoing e-government discussion. All interviews were conducted by two-person teams, with one researcher handling the interview questions, while the other recorded notes and observations. As many members of parliament would not permit recording, we used this common and successful procedure for undertaking interviews in case study research to obtain valid data (Eisenhardt & Bourgeois, 1988).

By combining as many methods as possible we added richness and depth to our research findings. The research team also used multiple investigators to enhance the creative potential of the study and to increase confidence in our findings. This involved the convergence of the observations from our multiple investigators, knowing the conflicting views could deter our research from premature closure (Eisenhardt, 1989). After transcription of the interviews, a case study database was built and used to manage this voluminous data and allowed all members of the research team to review all data collected directly.

During the analytical phase, which was to some extent overlapping with the data collection phase, different techniques were combined in an attempt to produce compelling and insightful conclusions. From time to time the research team wrote analytical memos that recorded the results of the tentative analyses and were based on our researchers field notes (Barley, 1990). For our initial data analyses one group of researchers used open-coding procedures and the other group used template analysis coding procedures. At this stage one part of the research team had no idea of what the data categories would be (Strauss & Corbin, 1990). The other research team started their coding using the research template (King, 1998). Both teams coded the material separately and compared their analyses afterwards. Within-case analysis was followed by a cross-case analysis covering all 11 cases to search for cross-case patterns by using divergent techniques. The collection of multiple types of data from different sources provided triangulation and increased the reliability of the study (Miles & Huberman, 1984). During one stage of the cross-case analysis the research team looked for similarities and differ-

ences between each of the 11 cases covering all the data. Afterwards, we tried another analysis and divided the data by data source to go beyond initial impressions (Eisenhardt, 1989).

Following an overall grounded theory approach, the research team iterated between the empirical data and possible theoretical conceptualization (Glaser & Strauss, 1967). By developing conjectures we attempted to compare systematically our emergent concept with the evidence from each case in order to assess how well or poorly it fitted with the data. As our findings were confirmed, at this stage of the research project, we started to compare our emergent concept with existing literature on the evolution of e-democracy, both conflicting and supporting literature, in order to enhance internal validity and further sharpen our final concept.

CASE BACKGROUND AND DESCRIPTION

The first Austrian policy document that could be called an e-government policy was created in 1997 by the Austrian Chancellery with the name 'Information Society' (Knoll & Grossendorfer, 1997). This ambitious programme concentrated on various aspects of IT diffusion and on how to lead Austria into the 21st century and addressed topics such as e-business, e-government and even e-democracy for the first time. The members of the working group – mainly senior government officials – were very sceptical towards e-democracy, despite the fact that the policy stated citizen participation in online dialogue could demonstrate an e-democracy future that could transform politics in highly effective ways. The so-called digital divide was seen as the main driver for unequal conditions in the consequent ability to access public services. So in the end, measures to counteract the digital divide were recommended, and measures promoting e-democracy were declined.

The current Austrian information and communications technology strategy is dominated by the European Commission's e-Europe initiative and its predecessors (EC, 1994; EC, 1997; EC, 1999; EC, 2002), with 'e-Austria in e-Europe' (Bundeskanzleramt, 2002) being the Austrian equivalent to it. This initiative is led by the Chief Information Office of the Austrian Federal Chancellery which published its own much more detailed e-government master plan (Posch, 2002). It became apparent that it was not possible to consolidate and expand what had been achieved so far in developing new e-government activities. Consequently, the Austrian Federal Government announced details of a new e-government agenda enabled by the Council of Ministers in May 2003 (Bundeskanzleramt, 2003). The ongoing initiative is composed of a new set of measures, co-ordinated with regional and local authorities, designed to implement a nationwide, uniform approach to e-government. Only one e-democracy project is included in the roadmap for 2004 and 2005 that consists of 70 e-government projects to be implemented within the next two years (Rupp, 2003). E-Democracy is addressed as an important topic for the future, but no concrete actions are proposed. All e-government documents on the regional level published by the nine Provincial Diets are totally lacking any statements concerning e-democracy.

Currently, there are a limited number of Austrian e-democracy examples, with only a few initiated by the academic sector as either pilot projects or applications restricted to a special local area with little public attention such as the 'E-Voting Project' for the student union elections run by the Vienna University of Economics and Business Administration (Prosser *et al.*, 2004) or the 'Online Election Stock Market' research project, which tried to predict the results of the regional election in Tyrol during 2003 (Filzmaier & Beyrl, 2003).

CASE FINDINGS

It is primarily the results of the cross-case analysis that are analysed in the following section of this paper. The research findings are reported by presenting evidence in the form of specific examples and comments gathered through the interview process. To make the discussion of these findings more meaningful, they are related to the two opposed aspects of the research question: politicians' support for e-administration and for e-democracy.

Parliamentarians and e-administration

Surprisingly, Austrian Parliamentarians are very well informed about the Federal Government's e-government activities, which can solely be found in the area of e-administration. Politicians of all parties frequently praise the positive effects of e-government at every opportunity. They also have a very high level of knowledge concerning the Austrian e-government vision. Some of the parliamentarians are actually able to name specific e-government projects that are related to potential scale economies and reduction of costs. E-government is advertised to the public as being a core of the long-delayed but eagerly awaited administrative reform with the ultimate goal of easing budgetary constraints at federal and provincial levels.

The vast majority of the Austrian parliamentarians are confident that with e-government politicians will be able to fulfil the obligation of finally reducing bureaucracy. Therefore, it is unsurprising that members of parliament view themselves as emissaries of a new, efficient, effective and consequently much cheaper system of public administration. However, despite their high expectations of e-government, there was a clear consensus across all interviews that e-government would change the administrative system only in the long run and that there were some substantial barriers hindering its further evolution. Parliamentarians also view a lack of resources and training as well as security and privacy issues as the most significant barriers to e-government. A member of the National Council described the situation as follows:

> The problem of unequal access to the internet is causing the problem of social exclusion. I think we are doing quite well compared to other countries but we also know that this problem will not easily be solved.

A parliamentarian who is a spokesman for IT issues on the provincial level noted:

> The digital divide is a serious problem. There is a whole set of measures which should successfully oppose a further widening of the digital skills gap. Together with international and

> local companies we will invest much more money in continuous IT education, and for the next year we are planning to increase public funding for an improvement of our broadband infrastructure.

A large group of politicians interviewed are also aware that there are at least as many barriers on the demand side of e-government as can be found on the supply side. Especially, members of the Provincial Diets – who have a much closer relationship to the regional administrative bodies – mentioned very clearly that e-government is not mainly about technology but that it also relates primarily to organizational and cultural change. In summary, for parliamentarians, the support for the further evolution of e-administration is not only reasonable but also necessary for the transformation of the administrative system. In addition, the interviews revealed another driver for the politicians' support of e-administration. In order to stem the decline of public confidence in government, the Austrian parliamentarians, together with their colleagues running for election, have identified e-government as a vehicle for improving the performance of public administration that should reduce the citizens' dissatisfaction with their political representatives.

Parliamentarians and e-democracy

Compared to e-administration, in the best case, e-democracy represents only a secondary existence in the minds of the Austrian parliamentarians. Generally, they do find the concept of e-democracy 'quite interesting', 'promising', and 'beneficial for democracy' as stated in official e-government documents and white papers issued by the different political parties or legislative bodies. While discussing the opportunities for more citizens' participation that the concepts of e-democracy are proposing, the politicians are very reserved on sharing their true position. Interestingly, we were able to observe a certain change in the politicians' path of argumentation against e-democracy during nearly all the interviews.

The first argument that the majority of the parliamentarians brought forward during the interviews was that it was current opinion that there would be important barriers that would hinder the implementation of e-democracy concepts. The politicians named the same barriers they had already mentioned when discussing e-administration: security and privacy issues, social exclusion and the digital divide, and the potential for manipulation. Unlike the previous discussions, the vast majority of the parliamentarians stated that there would be only very little chances of overcoming these barriers. During all the interviews this was the initial reason presented for justifying their marginal support for e-democracy. When asked for a more specific explanation of their arguments compared to their position on the potential of overcoming the same barriers in the area of e-administration, many of the politicians changed their course of argumentation. They tried to argue that the ordinary citizen was 'uninterested' in politics and 'unqualified' to participate. A member of a Provincial Diet described the rationale behind the approach by saying:

> There's more and more information for all of us and the process of political decision-making is getting more complex year by year. Now the citizens should work this out by themselves?

I think that's quite a silly concept. It's our job to deal with this complexity. That's why we become elected.

When asked about the future role of citizens in the process of political decision-making the majority of the politicians stated that the most important participatory activity for the citizens should be casting a vote into a ballot box. The further part of the interviews once again was directed towards a new set of arguments when the issue of displacement of political representation, as outlined in some concepts of e-democracy, appeared on the agenda of the interview. The responses from this specific focus were revealing as one parliamentarian, being more elegant in his argument, noted:

E-administration can facilitate changes and flexibility where red tape has caused torpor. This is not mainly an issue of influence or power, but an issue of more efficiency and effectiveness for the benefit of the citizens. But e-democracy would change the current balance of power towards the uninformed citizen. Do you really believe that a single representative will support this idea?

However, several politicians commented in a rather more straightforward way:

At the end of the day it is a question of power. More citizens' participation leads to a loss of power for the members of the political elite. We do not oppose a higher degree of transparency for the political system or a better flow of information related to our work towards the citizens. All these ideas are quite reasonable. But enabling the voters deciding on all and everything? That would cause the total annihilation of our system, of our networks and of our lobbies. For me and my colleagues it is a dangerous and alarming idea to let the internet take over the role of the political representatives. Very dangerous indeed. Politics is about balancing of interests of the people for the people.

Another parliamentarian who also confirmed that his colleagues are very much aware of the effects that e-democracy could cause and that the topic was already frequently discussed in internal committees noted:

A lot of my colleagues fear that we will see the internet causing the same effects of reorganization in the political system that the increased use of information systems has already caused in the private sector: more and more automating followed by layoffs. That's not what we want. We will definitely oppose such a development.

The vast majority of parliamentarians of all legislative bodies are taking a tough stance against the idea of more citizens' participation. One younger member of the Federal Council commented:

It is not about removing e-democracy from the agenda but to make sure that it will not appear on the agenda.

From the findings of our interviews, it is evident that currently the vast majority of Austria's politicians are very actively opposing e-democracy, although they are surprisingly well informed about its different concepts. Our observations would classify the possibly true reasons for their

approach into two groups: collective opposition to change and personal fear of change. First, parliamentarians in Austria strongly believe in the concept of representative democracy and are with the same dedication opposing any concept of deliberation. They are confident that they are much more qualified than the ordinary citizen and believe devoutly that it is solely the duty of the elite to make political decisions for all citizens. The different parties have discussed new concepts of digital democracy that propose much more citizen engagements. In this respect, the political systems seem to develop a widespread collective and distinctive scepticism concerning these concepts. This scepticism is driven by the fear of a lasting loss of power for the political elite when supporting e-democracy. They expect the political system as they know it to transform dramatically when changing the balance of power. Second, these notions make them believe that they are indispensable. Concepts of e-democracy that are highlighting the displacement of political representation are clearly threatening to individual politicians. Not only the ill-informed (making up only a small group in Austria) but also the very well-informed e-government experts among the parliamentarians are personally concerned about their own political future.

Fear of change appears to be the politicians' main driver for interfering with the further evolution of e-democracy. This leads to a special situation – the 'middleman paradox' – as the very same parliamentarians who would be responsible for introducing new forms of citizens' participation for political decision-making are explicitly and implicitly opposing these reforms.

Based on our findings, we want to shape the conjecture that the more citizens' participation-specific concepts of e-democracy are suggesting the less support for these concepts will be provided by politicians. The scenario cross in Figure 4 relates our assumption to Aström's model (Aström, 2001) of different dimensions of democracy which would add our emergent concept of the 'middleman paradox' to existing literature and theory in the area of e-democracy, political support and commitment for e-government (Margetts & Dunleavy, 2002; Chadwick & May, 2003; Jensen, 2003; Macintosh, 2003). On the horizontal axis the diagram is showing the 'level of citizens' participation with the 'level of political support for e-democracy concepts' on the vertical axis. The model suggests that in a 'thin democracy', the voter only wants to be informed as the mandate of the elected is open and therefore does not require direct citizen input. This would be an e-democracy scenario that would gain substantial support by the politicians as it presents no threat to their position. In the scenarios of 'strong democracy', which introduces the citizen as the former of opinions, the elected officials have to maintain constant interaction with the voters. The scenario of 'quick democracy', where the voters decide on all and everything and therefore do not have the time to discuss all of the topics in depth, would gain less or no support by the politicians. These concepts would dramatically alter the way political decisions are made and, to a more or less extent, displace the political representatives boosting deliberation.

LIMITATIONS

The findings of our research suffer from the usual limitations of interpretive case studies, in terms of generalization. As with any empirical investigation, weakness in the methodology and

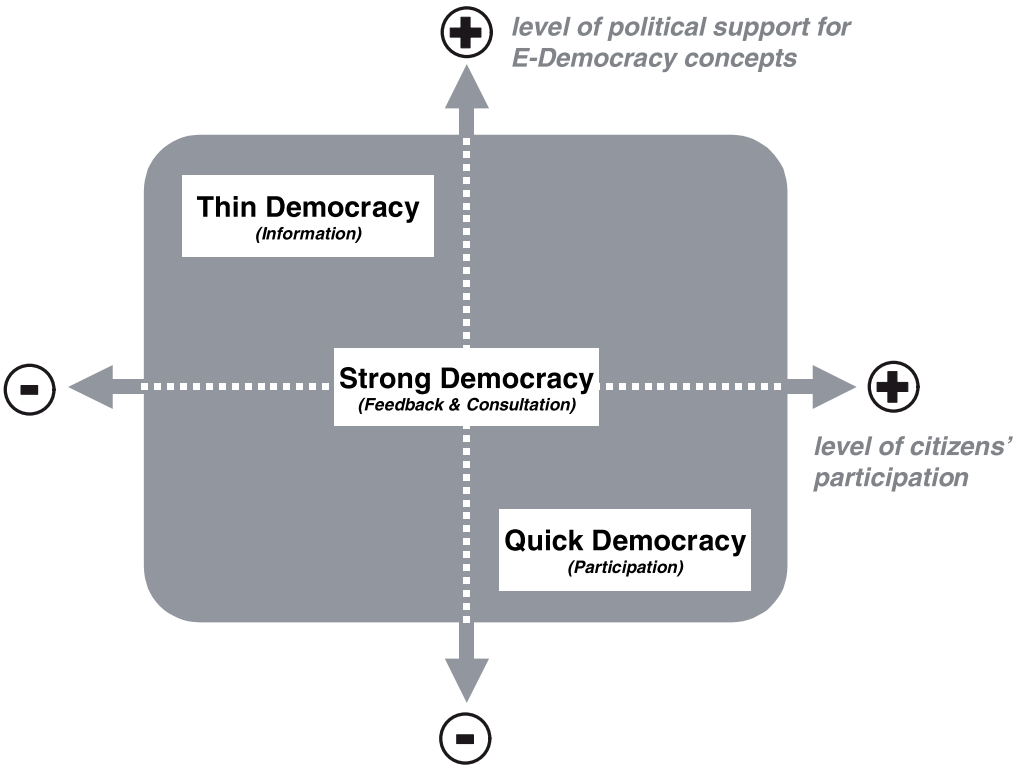

Figure 4. Support for concepts of e-democracy.

data will be present, and this study is no different. Two limitations, in particular, should be mentioned. First, we wanted to engage in theory-building in an area in which there has been relatively little prior research and therefore our observations could not be compared with a copious knowledge pool of previously consolidated findings. Second, the data utilized in this study were collected exclusively from legislative bodies in Austria. Although these 11 parliaments from the national and regional level may be representative of others throughout the world, this is by no means certain. As a result of these limitations some amount of scepticism is appropriate with regard to our findings. However, at the very least, the identification of the 'middleman paradox' in this study provides a good starting point for further research of the politicians' role for the future of e-democracy.

CONCLUSION

This paper provides an in-depth study of why politicians are inhibiting the further evolution of e-democracy. It illustrates that there are different levels of support for a variety of concepts

within e-government. Politicians are explicitly and implicitly fostering all activities in the area of e-administration, but they are otherwise interfering explicitly and implicitly in the advancement of e-democracy. Certainly, no examination of just 11 legislative bodies within only one country can produce a definitive generalization about the attitudes of politicians towards e-democracy around the globe. Nevertheless, the 'middleman paradox' introduced in our study describes that the very same politicians who would be responsible for introducing new forms of citizens' participation for political decision-making are afraid of a displacement of political representation and are therefore opposing more civic engagement.

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Biographies

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Article II

Volkamer, Melanie and **Robert Krimmer**. 2006. "Die Online-Wahl auf dem Weg zum Durchbruch." *Informatik-Spektrum* 29(2), 98-113. (1.2)

The majority of citizens in western democracies possess multiple chances per year to participate in an election, because several associations and pressure groups determine their representatives through elections that are more or less formal. Such decision-making processes require considerable preparation, resources, time, and money. The decline in voter turnout in western democracies since the 1970s and increasingly scarce public budgets intensify considerations to organize elections more effectively through electronic means in order to increase the accessibility of elections and to support voter mobility on election day. This paper gives an overview of electronic voting, its forms, the technical means for identification and authentication, and preserving secrecy of the vote. It concludes with an overview of Germany's experiences with remote electronic voting.

Die Online-Wahl auf dem Weg zum Durchbruch

Probleme und Lösungen für die Durchführung von Online-Wahlen in Deutschland

Melanie Volkamer · Robert Krimmer

In regelmäßigen Abständen müssen in Demokratien auf den verschiedensten Ebenen Wahlen und Abstimmungen abgehalten werden.

Neben den mit großem öffentlichem Interesse stattfindenden Bundestags-, Landtags- und Kommunalwahlen, auch Wahlen erster Ordnung genannt, gibt es eine Vielzahl weiterer Wahlen zweiter Ordnung wie Personal- und Betriebsrats-, Sozial-, Studentenvertretungs-, Vereins- sowie Pfarrgemeinderatswahlen. Jeder deutsche Bürger hat so zumeist mehrmals im Jahr die Möglichkeit, an Wahlen teilzunehmen. Um eine Wahl sicher und ordnungsgemäß durchzuführen, bedarf es neben einer routinierten Wahlorganisation vor allem auch viel Zeit und Geld. Seit Anfang der 70er Jahre ist eine zunehmende Wahlverdrossenheit zu verzeichnen, was sich in einem Rückgang der Wahlbeteiligung über alle Ebenen hinweg widerspiegelt. Diese Tatsachen führten zu Überlegungen, derzeitige Wahlverfahren durch den Einsatz von Computern zu reformieren, um die Kosten sowie den Zeitbedarf zu senken und die Zugänglichkeit und Wählermobilität am Wahltag zu erhöhen.

Einleitung

Seit Beginn der Entwicklung von Computern haben Visionäre wie Fromm, Fuller, Arterton oder Rheingold die Veränderung der Demokratie mit Hilfe der Informationstechnologie in Richtung des Athenischen Ideals einer direkten Demokratie erdacht. Neben diesen politologischen Überlegungen wurden früh auch theoretische technische Umsetzungen erarbeitet. So stellte Chaum 1981 [1] ein erstes theoretisches Wahlprotokoll vor, welches als fundamentale Grundlage für viele weitere Wahlprotokolle (z.B. [4, 8, 9]) gilt. Auftrieb für eine praktische Umsetzung bekamen diese Visionen durch den vom Internet angetriebenen großen Transformationsprozess in der Abwicklung der privaten Wirtschaft und der öffentlichen Verwaltung. Dies hatte zur Folge, dass verschiedene Projekte zur Erprobung von Online-Wahlen ins Leben gerufen wurden.[1] Das bekannteste deutsche Projekt ist das Projekt *Wählen in elektronischen Netzen* (kurz: W.I.E.N.), welches vom Bundesministerium für Wirtschaft und Arbeit (BMWA) gefördert wird und aus der *Forschungsgruppe Internetwahlen* der Universität Osnabrück entstanden ist. So wurden in Deutschland bis heute mehr als vierzig Online-Wahlen – davon etwa die Hälfte mit Rechtsgültigkeit – durchgeführt. Neben den praktischen Projekten ist seither auch eine Vielzahl wissenschaftlicher Arbeiten aus technischer, politischer, juristischer und gesellschaftlicher Sicht entstanden.

Die Diskussionen rund um das Thema Online-Wahlen wurden immer auch von Kritikern begleitet, die vor allem die Verletzung der Grundsätze der geheimen und gleichen Wahl und eine Gefährdung der „Institution Wahl" sehen. Neben dieser Kritik an

[1] Für einen Überblick über die Entwicklungen in anderen europäischen Ländern siehe die Proceedings des Workshop „Electronic Voting in Europe" [10].

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Zusammenfassung
Der Beitrag zeigt, welches die grundlegenden Probleme bei elektronischen Wahlen sind und welche interdisziplinären Fragen geklärt werden müssen, um in Zukunft Wahlen rechtsgültig über das Internet abzuwickeln. Nach der Klärung spezifischer Begriffe wird ein Einblick in die rechtlichen Grundlagen von Wahlen gegeben. Als Hauptbeitrag dieses Artikels werden Sicherheitsanforderungen an Online-Wahl-Systeme erklärt und zugehörige Sicherheitsmechanismen erläutert. Dabei wird das Hauptaugenmerk auf die in Deutschland eingesetzten Verfahren gelegt. Der Beitrag schließt mit einem Überblick über alle bisher in Deutschland durchgeführten Online-Wahlen und einer daraus abgeleiteten Empfehlung, was zu tun ist, um den Durchbruch von Online-Wahlen in naher Zukunft zu erreichen.

sozialen Ein- und Auswirkungen gibt es auch Kritiker der Technologie an sich, die die Lösbarkeit der informationstechnologischen Sicherheitsprobleme bezweifeln. Diese Stimmen sowie die fehlenden durchschlagenden Erfolge führten dazu, dass das Thema Online-Wahlen seit Ende 2002 bei vielen Wissenschaftlern und Politikern in Vergessenheit geriet.

Erst die Präsidiumswahl der *Gesellschaft für Informatik e.V.* (GI), die gezeigt hat, dass rechtsgültige Online-Wahlen mit großen Wählerzahlen (rund 20.000 Wahlberechtigte) sehr wohl erfolgreich durchgeführt werden können, führte dazu, dass Online-Wahlen wieder zu einem Diskussionspunkt wurden, insbesondere auch in der Fachgruppe ECOM – „E-Commerce, E-Government und Sicherheit" –, die sich derzeit intensiv mit dem Thema beschäftigt. Verstärkt wird das Interesse durch die soeben beendete zweite Online-Wahl der GI und dadurch, dass auch die *Initiative D21* im Oktober 2005 bereits ihre zweite Vorstandswahl elektronisch abgewickelt hat.

Betrachtet man die ganze historische Entwicklung von Online-Wahlen, entstehen die Fragen, warum es noch nicht zum flächendeckenden Einsatz von Online-Wahl-Systemen gekommen ist, warum der deutsche Online-Wahl Pionier Dieter Otten sein Vorhaben „*zur Europawahl 2004 […] ein rechtskräftiges Wahlverfahren über das Internet anbieten zu können*" nicht umsetzen konnte und warum die diesjährigen Bundestagswahlen nicht, wie von der Initiative D21 gefordert, online durchgeführt wurden. Weiter stellt sich die Frage, ob durch die jüngsten Projekte der Durchbruch erreicht wird.

In diesem Beitrag wird gezeigt, was die grundlegenden Probleme bei elektronischen Wahlen sind und welche interdisziplinären Fragen geklärt werden müssen, um in Zukunft Wahlen rechtsgültig über das Internet abzuwickeln. Zu Beginn werden verschiedene spezifische Begriffe erklärt und gegeneinander abgegrenzt. Außerdem wird ein Einblick in die rechtlichen Grundlagen von Wahlen gegeben. Als Hauptbeitrag dieses Artikels folgen ein Überblick über die verschiedenen Sicherheitsanforderungen an Online-Wahl-Systeme und eine Erörterung zugehöriger Sicherheitsmechanismen, insbesondere über diejenigen, die bei den in Deutschland durchgeführten Online-Wahlen zum Einsatz gekommen sind. Der Beitrag schließt mit einer Empfehlung an alle Beteiligten, was sie tun sollten, um den Durchbruch von Online-Wahlen in naher Zukunft zu erreichen.

Wahlformen

Die Art, wie Wahlen durchgeführt werden, hängt sehr stark vom jeweiligen Umfeld ab. Doch unabhängig davon lassen sich zwei wesentliche Grundformen erkennen: die *Distanz-* und die *Präsenzwahl*, die sich durch den Ort der Stimmabgabe bzw. die Anwesenheit von Wahlhelfern unterscheiden. Ein hierzu orthogonales Unterscheidungskriterium ist das Medium der Stimmabgabe. Hier spricht man von *papierbasierter-* bzw. *elektronischer Wahl*.

Wählt man diese Unterscheidungsmerkmale, also den ‚Ort' und das ‚Medium' der Stimmabgabe, lassen sich folgende vier Grundformen und zwei Mischformen unterscheiden:

Papierbasierte Wahl

Die *papierbasierte Wahl* beinhaltet alle Wahlformen, die als Medium zur Erfassung der Stimme Papier einsetzen. Der Ort der Stimmabgabe ist dabei wesentliches Unterscheidungsmerkmal.

Urnenwahl

Hierbei handelt es sich um die „klassische" Form der Wahl, bei der der Wähler/die Wählerin am Wahltag in das ihm/ihr zugeteilte Wahllokal geht, um die

Abstract
In this article the basic problems of remote electronic voting are described. In addition, the interdisciplinary questions are discussed. After a clarification of e-voting specific terms an introduction to the legal regulations for elections is given. The main contribution of this article is the presentation of security requirements for remote electronic voting and the respective security mechanisms to fulfil the requirements. The paper concludes with an overview of all remote electronic votings conducted in Germany. From these experiences, recommendations on how to make remote electronic voting work are derived.

Stimme auf einem normierten und eigens für die Wahl produzierten Papierstimmzettel abzugeben. Für die ordnungsgemäße Abwicklung der Wahl sorgen Wahlhelfer. Es handelt sich dabei also um eine *Papier-Präsenzwahl*.

Briefwahl

Bei der Briefwahl kann der Wähler/die Wählerin seinen/ihren Papierstimmzettel statt im Wahllokal an einem von ihm/ihr gewählten Ort ausfüllen und auf dem Postweg der Wahlzentrale zusenden. Üblicherweise muss dafür erst ein Antrag gestellt werden und danach werden die Unterlagen auf dem Postweg an die Wählerin übermittelt. Die Sicherstellung einer ordnungsgemäßen Abwicklung der Wahl obliegt dem Wähler/der Wählerin selbst, was in Deutschland durch die Abgabe einer eidesstattlichen Erklärung dokumentiert wird. Diese Form wird auch als *Papier-Distanzwahl* bezeichnet.

Elektronische Wahl

In Analogie zur Empfehlung des Europarats zu E-Voting [2] lassen sich alle Wahlformen, bei denen zumindest die Stimmabgabe an einem elektronischen Gerät erfolgt, unter dem Oberbegriff *elektronische Wahl* zusammenfassen.

Wahlgeräte

Erfolgt die Stimmabgabe an einem elektronischen Gerät im Wahllokal, spricht man von Wahlgeräten. Da diese in ihrem Funktionsumfang und unter dem Gesichtspunkt der Sicherheitsanforderungen stark differieren, muss man sie noch weiter untergliedern. Die bereits in Deutschland eingesetzten Wahlgeräte sind die *Stand-alone-Wahlgeräte*. Sie speichern die abgegebenen Stimmen lokal und zählen sie am Ende der Wahl aus. Im Gegensatz dazu steht die Online-Wahl im Wahllokal, bei der *vernetzte Wahlgeräte* zum Einsatz kommen. Dies bedeutet, dass entweder die Wahlberechtigungsprüfung, die Stimmabgabe oder beide Prozessschritte (Berechtigungsprüfung und Stimmgabe) online erfolgen.

Alle hier beschriebenen Formen werden auch als *elektronische Präsenzwahl* bezeichnet.

Remote Online-Wahl

Diese Form ist unter vielen Begriffen bekannt, darunter Remote E-Voting, Internetwahl und Mobil-Voting. Wichtig ist hierbei, dass die Wahlberechtigungsprüfung und die Stimmabgabe über einen Online-Kanal von einem beliebigen elektronischen Endgerät erfolgt. Vorrangig kommen dabei als Endgeräte PCs und als Kommunikationsmedium das Internet zum Einsatz. Diese Formen stellen die *elektronische Distanz-Wahl* dar.

Mischformen

Neben diesen vier Wahlformen gibt es auch noch zwei Mischformen, die anhand der zuvor genannten Kriterien nicht eindeutig einer der Klassen zugeordnet werden können: der Auszählungsautomat und die Online-Wahl am Kiosk.

Auszählungsautomat

Die *Auszählautomaten* stellen eine Mischform aus papierbasierter und elektronischer Wahl dar. Hierbei werden die Papierstimmzettel automatisch eingelesen, ausgewertet und das Ergebnis berechnet. Bekannte Beispiele hierfür sind die kalifornischen Wahlgeräte von AccuVote sowie der in Hamburg zur diesjährigen Bundestagswahl testweise eingesetzte digitale Stift, der nach jeder Stimmabgabe ausgelesen wird.

Online-Wahl am Kiosk

Die *Online-Wahl am Kiosk* ist eine Mischform zwischen der elektronischen Präsenz- und Distanzwahl. Hierbei stehen die vernetzten Wahlgeräte nicht in einem Wahllokal unter Aufsicht der Wahlhelfer, sondern in öffentlich zugänglichen Gebäuden und Räumen wie Bibliotheken, Schulen

und Einkaufszentren. Sie müssen daher ähnlich den Geldausgabeautomaten besonders gegen Vandalismus, Manipulation und Ausspähung der Stimmabgabe geschützt sein.

Zusammenfassung

Die beschriebenen Wahlformen lassen sich unter den zuvor genannten Gesichtspunkten ‚Ort der Stimmabgabe' und ‚Medium der Stimmabgabe' als Matrix, wie in Tabelle 1 geschehen, darstellen.

Diese Aufstellung ist deshalb sehr wichtig, weil sie eine saubere Trennung zwischen allgemeinen und informationstechnisch-spezifischen Anforderungen an Wahlen erlaubt. Als Beispiel seien hier nur die vielfach diskutierten Probleme des Stimmenkaufs und Wahlzwangs genannt, die bei allen Formen der Distanzwahl, also auch der Briefwahl und der Remote Online-Wahl, die gleichen sind.[2]

Außerdem zeigt diese Aufstellung auch, dass mit dem vielfach verwendeten Begriff „Online-Wahl" verschiedene Wahlformen gemeint sein können:

1. Online-Wahl im Wahllokal (vernetzte Wahlgeräte)
2. Online-Wahl am Kiosk
3. Remote Online-Wahl

Allen dreien ist gemein, dass eine direkte Verbindung zwischen dem Endgerät (Wahlgerät, Kiosk, PC/Handy) und einem zentralen Server zur Übermittlung der Wahlberechtigung oder der Stimmabgabe besteht, allerdings jeweils mit komplett unterschiedlichen Problemstellungen.

In diesem Artikel konzentrieren wir uns auf die Remote-Online-Wahl, welche die technisch spannendste, gleichwohl gesellschaftlich und juristisch umstrittenste Form darstellt.

[2] Siehe den Beitrag der Autoren in [6].

Tabelle 1

	Präsenzwahl	Distanzwahl
Papierwahl	Urnenwahl	Briefwahl
Elektronische Wahl	Stand-alone Wahlgerät Vernetztes Wahlgerät (Online-Wahl im Wahllokal)	Remote Online-Wahl (PC, Handy)
	Online-Wahl am Kiosk	

Auszählautomat

Rechtsgrundlagen

Auch wenn auf den ersten Blick eine elektronische Abbildung der herkömmlichen Wahlformen, wie im vergangenen Kapitel aufgezeigt, einfach erscheinen mag, so ist dies aus rechtlicher Sicht schwierig. Derzeit sind für Wahlen in Deutschland nur Stand-alone-Wahlgeräte gesetzlich zugelassen. Nach dem Bundeswahlgesetz sind solche Geräte seit 1975 in mechanischer Form und seit 1999 in elektronischer Form zu Wahlen des Deutschen Bundestages sowie zu Europaratswahlen[3] zulässig. Die Anforderungen an diese Stand-alone-Wahlgeräte legt die Bundeswahlgeräteverordnung fest. Die entsprechenden Geräte werden vor ihrem Einsatz von der Physikalisch Technischen Bundesanstalt (PTB) geprüft und erhalten ggf. vom Bundesministerium des Inneren (BMI) die Bauartzulassung.

Die Online-Wahl ist dagegen nur in Einzelfällen zulässig. So ist beispielsweise in Abschnitt 3.5.4 der Satzung der Gesellschaft für Informatik e.V. festgelegt, dass „der Briefwahl […] vergleichbar sichere elektronische Wahlverfahren gleich gestellt" sind. Ihre *Ordnung der Wahlen und Abstimmungen (OWA)* regelt die Details für ein elektronisches Wahlverfahren.

In allen anderen Bereichen ist die Online-Wahl noch in den Wahlgesetzen und entsprechenden Verordnungen zu verankern. Dabei kann auch auf entsprechende Vorarbeiten im Rahmen des Europarates zurückgegriffen werden. Am sinnvollsten erscheint es, analog zur Bundeswahlgeräteverordnung eine *Online-Wahlverordnung* zu erlassen, in der die Anforderungen an das System und die Durchführung sowie die Zuständigkeiten für Prüfung und Zulassung festgelegt sind. Problematisch erscheint hier insbesondere, dass einerseits die PTB und das BMI große Fachkenntnis und Erfahrung bezüglich der Prüfung von Wahlgeräten haben und andererseits die Expertise für die Prüfung und Zertifizierung von sicherheitskritischen IT-Produkten nach ITSEC bzw. den zukunftsweisenden Common Criteria (CC) beim Bundesamt für Sicherheit in der Informationstechnik (BSI) und den vom BSI akkreditierten Prüfstellen liegt. Es bleibt damit zu

[3] In allen Bundesländern bis auf Brandenburg, Hessen, Nordrhein-Westfalen, Rheinland-Pfalz und Sachsen-Anhalt dürfen diese Stand-alone-Wahlgeräte auch für Landes- und Kommunalwahlen eingesetzt werden.

klären, in welcher Konstellation diese Einrichtungen zusammenarbeiten werden.

Bei der Erstellung einer Online-Wahlverordnung ist zu beachten, dass ein Online-Wahl-System die Grundanforderungen an eine verfassungskonforme Wahl einhalten muss. Diese Grundanforderungen werden durch die fünf *Wahlrechtsgrundsätze*, die eine *allgemeine, unmittelbare, freie, gleiche und geheime* Wahl fordern, abgedeckt. Sie sind in Deutschland bereits im Grundgesetz verankert und regeln hier die Wahl der Abgeordneten des deutschen Bundestages. Dabei verlangt der Grundsatz der allgemeinen Wahl die Gleichheit für alle Wahlberechtigten beim Zugang zur Wahl. Der zweite Wahlrechtsgrundsatz der unmittelbaren Wahl verlangt, dass sich die abgegebene Stimme unmittelbar auf das Ergebnis auswirkt und keine Wahlmittelsmänner eingeschoben werden dürfen. Der Wahlrechtsgrundsatz der gleichen Wahl verlangt eine Zählwert- und Erfolgswertgleichheit aller Stimmen. Dass jeder Wähler sein Wahlrecht ohne Zwang und unzulässige Beeinflussung abgibt, stellt die freie Wahl sicher. Der letzte Wahlrechtsgrundsatz der geheimen Wahl schreibt eine obligatorische und unverzichtbare geheime Wahl für alle Wähler vor, wobei das Wahlgeheimnis zeitlich unbegrenzt sichergestellt werden muss.

Darüber hinaus ist zu beachten, dass in Deutschland die herkömmliche Urnenwahl in Form einer Präsenzwahl die Regelwahlart darstellt. Dagegen ist die Distanzwahl in Form der Briefwahl nur als Ausnahmeregelung erlaubt. Der Grund dafür ist die im Wahllokal durch eine Wahlkabine und die Wahlhelfer gegebene sichere Umgebung zur Stimmabgabe, die eine geheime und freie Stimmabgabe ermöglicht. Dagegen liegt es bei der Briefwahl in der Verantwortung der Wählerin/des Wählers, dass sie/er ihre/seine Stimme unbeobachtet und unbeeinflusst abgibt, was sie mit einer Eidesstattlichen Erklärung beteuert. Dass diese Problematik und damit die klare Trennung zwischen Präsenz- und Distanzwahl nicht zu unterschätzen ist, zeigen auch Klagen vor dem Bundesverfassungsgericht. Daher ist diese Differenzierung auch bei elektronischen Wahlen zu beachten.

Selbst wenn die Onlinewahl in den Bundesgesetzen inklusive einer eigenen Online-Wahlverordnung verankert wäre, muss diese aber noch in den entsprechenden anderen Wahlgesetzen auf anderen Ebenen, sei es in Vereinssatzungen, in der Wahlordnung von Betriebsräten etc. umgesetzt werden. Diese Umsetzung ist je nach Bereich, in dem die Online-Wahl eingesetzt werden soll, unterschiedlich einfach oder schwer. Dies hängt zunächst davon ab, ob der politische Wille vorhanden ist oder nicht. Ein weiterer Einflussfaktor ist die bisherige Wahlform, ob eine reine Briefwahl vorgesehen ist oder ob die Briefwahl die Ausnahme darstellt. So eignen sich – aus rein juristischer Sicht – Bereiche, in denen die Wahlen nicht gesetzlich geregelt sind, am ehesten für die Online-Wahl, da sich die Organisation hier selbst ihre Wahlordnung gibt. Außerdem eignen sich Bereiche, in denen derzeit ausschließlich per Briefwahl gewählt wird, eher als andere zur Einführung der Remote-Online-Wahl, da hier keine Diskussion bzgl. der Distanzwahlproblematik nötig ist. Hierzu zählen beispielsweise die Sozialwahlen.

Sicherheitsanforderungen

Auch wenn noch keine konkrete Online-Wahlverordnung existiert, so gibt es doch eine Reihe von Überlegungen und Katalogen[4], die Anforderungen für ein Online-Wahl-System definieren. Die bekanntesten und umfangreichsten Zusammenstellungen von Anforderungen an Online-Wahl-Systeme sind der Anforderungskatalog für *Online-Wahlen für nicht-parlamentarische Wahlen* der PTB [5], der auf die Online-Wahl im Wahllokal abzielt, sowie die *Empfehlung des Europarates* [2], die sich auf die Remote-Online-Wahl konzentriert.

Untersucht man diese Kataloge genauer, lassen sich die darin enthaltenen Anforderungen in drei Kategorien unterscheiden: 1. die sicherheitstechnischen und 2. die funktionalen Anforderungen an ein Online-Wahl-System sowie 3. die organisatorischen Anforderungen an die Wahlvorbereitung und -durchführung.

Sicherheitstechnische Systemanforderungen

Die sicherheitstechnischen Systemanforderungen werden von den allgemeinen Wahlrechtsgrundsätzen abgeleitet. Die Sicherheitstechnik betrifft die Software der Online-Wahlsystemkomponenten wie auch das zugrunde liegende Kommunikationsprotokoll. Eine Operationalisierung der Grundsätze in Form von Anforderungen findet sich in allen

[4] Eine Zusammenstellung der verschiedenen Überlegungen in Form von Anforderungskatalogen ist unter [14] online verfügbar.

Katalogen. Sie enthalten immer die folgenden Punkte:

1. Zu keinem Zeitpunkt darf eine Zusammenführung von Wählerin und abgegebener Stimme hergestellt werden können. Darüber hinaus darf das System der Wählerin/dem Wähler nicht die Möglichkeit geben, ihre/seine Stimme gegenüber anderen zu beweisen (*Anonymität: Grundsatz der geheimen und freien Wahl*).
2. Eine zuverlässige und eindeutige Identifizierung muss sichergestellt werden. Nur Wahlberechtigte dürfen wählen und jeder darf seine Stimme nur einmal abgeben. (*Authentifizierung: Grundsatz der allgemeinen und gleichen Wahl*).
3. Es darf an keiner Stelle – weder bei der Übertragung noch bei der Speicherung – möglich sein, Stimmen unbemerkt zu verändern, zu löschen oder hinzuzufügen (*Integrität: Grundsatz der allgemeinen und gleichen Wahl*).
4. Die Berechnung von Zwischen- oder Teilergebnissen muss ausgeschlossen werden (*Integrität: Grundsatz der allgemeinen und gleichen Wahl*).
5. Das Ergebnis muss korrekt ausgezählt werden, insbesondere müssen alle abgegebenen Stimmen auch gezählt werden (*Korrektheit: Grundsatz der allgemeinen und gleichen Wahl*).
6. Das Online-Wahl-System muss für alle Server ein Back-Up-System haben und für sämtliche Ausfälle der Server und der Kommunikation, wie auch eines Endgeräts einen Wiederanlaufmechanismus definieren (*Robustheit: Grundsatz der allgemeinen und gleichen Wahl*).

Die genannten Anforderungskataloge unterscheiden sich jedoch in Bezug auf die Verifizierbarkeit des Wahlvorgangs und des Ergebnisses. Teilweise wird sogar gefordert, dass alle Wähler verifizieren können müssen, dass ihre Stimme gezählt wurde. In anderen Katalogen verfolgt man den Ansatz, dass die Korrektheit der Ergebnisberechnung von allen Wählern verifiziert werden können muss.

Funktionale Systemanforderungen

Unter funktionalen Anforderungen versteht man wahlspezifische Durchführungsanforderungen, die je nach spezifischer Wahl oder Organisation, in der die Wahl durchgeführt wird, neu definiert werden können. Dies umfasst üblicherweise Form und Aussehen der Stimmzettel, die Wahlperiode (einerseits lang genug, um DoS-Angriffe sinnlos zu machen und andererseits nicht zu lang, damit Politiker nicht zu oft ihre Meinung ändern), Aus- und Nachzählung der Stimmen, unterstützte Client-Betriebssysteme sowie meistens auch die Definition der Inhalte des Wählerverzeichnisses.

Am wichtigsten erscheint aufgrund der internationalen Diskussion die Festlegung der Anforderungen rund um den Stimmzettel. Die gleiche Wahl fordert, dass die Stimmzettel in Papier- und in elektronischer Form jeweils die gleichen Chancen für alle Kandidaten einräumen. Es muss insbesondere festgelegt werden, wie mit Stimmzetteln umgegangen wird, die nicht auf den Bildschirm passen. Weiterhin muss geklärt sein, wie mit ungültigen Stimmen umgegangen wird. Es ist festzulegen, ob und in welcher Form (z.B. in Form eines Buttons oder eines ungültigen Kandidaten) die bewusste ungültige Stimmabgabe ermöglicht werden soll. Weiterhin muss beim Stimmzettel der Punkt „Schutz vor Übereilung“ Berücksichtigung finden. Hierbei soll durch eine Rückfrage „Sie wählen hiermit XY. Sind Sie sicher?“ eine vorschnelle Stimmabgabe vermieden werden.

Die Liste an funktionalen Anforderungen ist sehr umfangreich und findet sich vor allem in den Empfehlungen des Europarats wieder. Allen Anforderungen ist gemein, dass hier ein großer Entscheidungsspielraum besteht und es sich vor allem um politische Entscheidungen handelt, wie mit den einzelnen Fragen umgegangen wird.

Organisatorische Anforderungen

Die organisatorischen Anforderungen betreffen weniger das Online-Wahl-System an sich, sondern vielmehr Vorgehensvorschriften wie die Inbetriebnahme und Bedienung der Server, die Erstellung des zentralen elektronischen Wählerverzeichnisses, die Information der Wählerinnen und Wähler oder die Verteilung der Wählerauthentifizierungsmerkmale.

Entwicklung eines Schutzprofils

In den existierenden Katalogen sind bereits umfassende sicherheitstechnische, funktionale und auch organisatorische Anforderungen definiert worden, die bei der Entwicklung entsprechender Systeme berücksichtigt werden können und sollen. In Bezug auf eine Prüfung, ob ein System einen speziellen Anforderungskatalog erfüllt oder nicht, ist ein wesentlicher Aspekt, der bisher ausgelassen worden war die *Definition der Rahmenbedingungen*.

Es wird nämlich nicht festgeschrieben, unter welchen Rahmenbedingungen ein Online-Wahl-System die definierten Anforderungen erfüllen muss. Es müssen also die Anforderungen an die Umgebung und das Bedrohungspotenzial festgelegt werden. Erst dann kann entschieden werden, ob ein System die Anforderungen erfüllt. Genau dies hat auch die Expertenrunde, die die GI-Wahlen begleitet, erkannt und daher eine Arbeitsgruppe unter Leitung von Rüdiger Grimm ins Leben gerufen, die das Ziel verfolgt, ein Common Criteria Protection Profile (Schutzprofil) für Online-Wahlen zu entwickeln. Es soll nicht nur die fehlenden Punkte abdecken, sondern sorgt gleichzeitig für eine international akzeptierte Strukturierung der Anforderungen mit dem besonderen Vorteil, dass das Vorgehen zur Prüfung einheitlich und bekannt ist. Hierbei ist derzeit noch die Frage nach der Evaluierungsstufe zu klären.

Sicherheitsmechanismen

Aus den zahlreichen technischen Anforderungen sind die beiden Basisanforderungen *Wählerauthentifizierung* und *Anonymität der Stimme* hervorzuheben. Der Wähler muss eindeutig identifiziert und authentifiziert werden und gleichzeitig seine Stimme vollständig anonym abgeben können. Ein weiteres Merkmal des Sicherheitsdesigns eines Wahlsystems ist die Gestaltung und Umsetzung der *Sicherheit am Endgerät*. Die derzeit vornehmlich eingesetzten Mechanismen werden daher im Anschluss vorgestellt.

Wählerauthentifizierung

Ein wichtiger Bestandteil jedes Online-Wahl-Systems stellt die Identifizierung (durch die Eingabe einer eindeutigen Wählerkennung) gegenüber dem System und die anschließende Authentifizierung (Echtheitsnachweis der Identität) dar. Dieser Nachweis ist erforderlich, um sicherstellen zu können, dass nur Wahlberechtigte eine Stimme abgeben können, jeder Wahlberechtigte nur eine Stimme abgeben kann und insbesondere nicht jemand für eine andere Person wählen kann. Unter anderem wird damit auch der Bedrohung des Stimmenkaufs[5] entgegengewirkt.

[5] Beim Stimmenkauf können zwei Formen unterschieden werden: Entweder der Wähler kann seine Kandidatenwahl dem Käufer beweisen oder der Wähler gibt dem Käufer die Möglichkeit selbst die Stimme abzugeben, beispielsweise indem er ihm sein Authentifizierungsmerkmal überlässt.

Die Identifikation erfolgt über den Namen sowie über weitere persönliche Angaben, die die Wählerkennung einmalig machen. Der Wahlberechtigte überträgt zur Wahlberechtigungsprüfung neben seiner Wählerkennung sein Authentifikationsmerkmal oder Daten, die mit Hilfe dieses Merkmals erzeugt wurden. Es wird zwischen drei Authentifikationsmerkmalen unterschieden:

1. in Form eines Geheimnisses (z.B. ein Passwort),
2. in Form eines Besitzes (z.B. ein elektronisch lesbarer Bibliotheksausweis) oder
3. in Form bestimmter persönlicher Eigenschaften (z.B. der eigene Fingerabdruck).

In der Praxis wird zumeist eine Mischung aus den oben genannten Formen eingesetzt. Die für die Remote-Online-Wahl relevanten Verfahren werden im Folgenden bzgl. ihrer Sicherheit, Benutzerfreundlichkeit und Kosten diskutiert.

Authentifizierung durch die Kenntnis eines Geheimnisses

Eine Möglichkeit der Identifikation und Authentifizierung erfolgt analog zum Anlegen eines Email-Accounts. In der Vorbereitungsphase kann man sich entsprechend einen Wahl-Account anlegen (Festlegen der Nutzerkennung und des Passwortes durch den Wähler), über den man sich bei der eigentlichen Wahl einloggt, um seine Stimme abzugeben.

Auch wenn dieser Ansatz aus Anwendersicht einfach handhabbar und benutzerfreundlich ist, so hat er doch drei Schwachstellen: Erstens kann nicht ausgeschlossen werden, dass auch Personen, die gar nicht wahlberechtigt sind, einen Account anlegen. Zweitens besteht die Gefahr, dass die Wähler einfach zu brechende Passwörter wählen. Drittens kann Stimmenkauf nicht ausgeschlossen werden, da die Wahlberechtigten ihre Zugangsdaten ohne großen Aufwand an einen potentiellen Käufer versenden können.

Eine weitere Umsetzung der Authentifizierung durch Kenntnis eines Geheimnisses stellt die Verwendung einer Wahl-TAN dar. Diese wird Wahlberechtigten vor der Wahl zugeschickt. Diese Variante ist der Authentifizierung mittels eines Geheimnisses bzgl. Benutzerfreundlichkeit sehr ähnlich. Die Kosten dagegen steigen, da den Wahlberechtigten die Wahl-TAN (aus Sicherheitsgründen) mit der Post zugeschickt wird. Dafür steigt aber die

Sicherheit, da die Wahl-TAN vom Veranstalter entsprechend schwer zu brechen gewählt wird. Es bleibt aber die Gefahr des Weitergebens der Wahl-TAN zwecks Stimmenkaufs.

Authentifizierung durch Besitz

Die zweite Kategorie bildet die Authentifizierung mittels eines Besitzes. Hierbei lassen sich zwei Varianten unterscheiden:

1. Verwendung einer Wahl-Chipkarte, die ebenfalls vor der Wahl den Berechtigten zugestellt wird,
2. Verwendung einer Chipkarte, die die/der Wahlberechtigte bereits besitzt und zur Berechtigungsprüfung in anderen Bereichen nutzt, wie etwa seine Jobkarte oder seinen Bibliotheksausweis.

Entscheiden sich die Verantwortlichen den Wählern statt der Wahl-TAN eine Wahl-Chipkarte zuzuschicken, dann erhöhen sie damit einerseits die Sicherheit, da der Stimmenkauf und das illegale Erzeugen des Authentifizierungsmerkmals erschwert werden. Dafür wird in Kauf genommen, dass die Kosten erheblich steigen. Neben den Kosten für die Erzeugung und Verteilung der Chipkarten entstehen auf der Seite des Wählers ebenfalls erhebliche Kosten für einen entsprechenden Kartenleser. Das Anschließen und Installieren dieses Kartenlesers an den eigenen Rechner wirkt sich daneben negativ auf die Benutzerfreundlichkeit aus.

Einige der Nachteile dieser Authentifizierungstechnik lassen sich durch den Einsatz einer bereits vorhandenen und in anderen Bereichen eingesetzten Karte ausräumen. Es bleiben aber die Kosten für das Kartenlesegerät, falls der Wähler ein solches noch nicht besitzt. In Bezug auf Stimmenkauf ist ebenfalls eine Verbesserung erreicht, weil ausgeschlossen werden kann, dass Wahlberechtigte ihre Karte zur Stimmabgabe an einen Käufer weitergeben, da sie ihm damit auch Berechtigungen wie Raumzugänge oder ähnliches weitergeben würden. Die Benutzerfreundlichkeit ist insofern gestiegen, als die Wahlberechtigten bereits mit dem Umgang mit der Karte aus anderen Bereichen vertraut sind.

Authentifizierung durch persönliche Eigenschaften

Die dritte Form der Authentifizierung erfolgt durch eine persönliche (biometrische) Eigenschaft eines Wählers. Die gebräuchlichsten biometrischen Eigenschaften eines Menschen sind sein Fingerabdruck, seine Augen (Iris) oder sein Gesicht. Die Überprüfung der über entsprechende Scanner eingelesenen Daten erfolgt durch Abgleich mit einer Datenbank oder in Kombination mit der Signaturkarte des Wählers auf der Grundlage der dort gespeicherten biometrischen Wähler-Daten. Dieser Ansatz stellt ein Höchstmaß an Sicherheit bzgl. einer eindeutigen Wählerauthentifizierung dar, da biometrische Merkmale nicht weitergegeben werden können. Die Nachteile dieses Ansatzes liegen in den Kosten für die derzeit nicht vorhandene Infrastruktur und der fehlenden Reife der Technologien insbesondere im Zusammenhang mit großen Populationen. Darüber hinaus ist bei der bisherigen Forschung die *False Rejection Rate (FRR)* vernachlässigt worden, da für die Sicherheit in erster Linie die *False Acceptance Rate (FAR)* eine Rolle spielt. Bei Wahlen wird durch eine False Rejection allerdings die Allgemeinheit der Wahl verletzt.

Authentifizierung durch Mischtechniken

In der Praxis kommen zumeist Mischformen der oben genannten Authentifizierungsformen zum Einsatz. Die bekanntesten sind die Kombination aus Besitz und Geheimnis in Form der Signaturkarte zur Erzeugung qualifizierter elektronischer Signaturen und die Kombination aus Besitz und Eigenschaft, bei der die Überprüfung der biometrischen Daten lokal auf einer Karte erfolgt, um das Problem mit dem Datenschutz zu umgehen. Der Einsatz dieser Mischtechniken ermöglicht maximale Sicherheit, da die Imitation dieser Karten sowie die Weitergabe ausgeschlossen werden kann. Benutzerfreundlichkeit und Kosten hängen davon ab, ob die Wahlberechtigten bereits über diese Karte verfügen und sie einsetzen.

Bei einer Entscheidung für eine der Varianten gilt es immer, Sicherheit, Benutzerfreundlichkeit und Kosten einander gegenüberzustellen.

Anonymität der Stimmabgabe

Die Herstellung vollständiger Anonymität bei gleichzeitiger eindeutiger Identifizierung und Authentifizierung der Wahlberechtigten gilt in den Kreisen von Kryptologen als die Königsdisziplin, womit vermutlich die große Anzahl an technischen Lösungsvorschlägen für Wahlprotokolle zu erklären ist.

Für die Einteilung der verwendeten Anonymitätsverfahren gibt es bereits umfangreiche Untersuchungen, die die zahlreich vorhandenen Protokolle in Protokollfamilien untergliedern. In seiner Dissertation hat Manhard Schlifni eine der differenziertesten Klassifikationen [11, S. 130] mit acht verschiedenen Varianten vorgenommen. In der Praxis wird aber nur eine Auswahl davon auch tatsächlich eingesetzt. In Anlehnung an Schlifni werden daher im Folgenden die drei Kategorien vorgestellt, die bei der Durchführung von Online-Wahlen am häufigsten zum Einsatz gekommen sind: 1. Systeme mit *vorgelagerter Wähleridentifizierung*, 2. *Systeme mit verdeckter Auswertung* (Homomorphe Systeme, Hardware Security Module) und 3. *Systeme mit Blinder Signatur*.

Systeme mit vorgelagerter Wähleridentifikation

Bei diesen Online-Wahl-Systemen wird allen Wahlberechtigten ein zufälliges Geheimnis per Post oder eMail zugestellt. Anschließend sind zwei Formen zu unterscheiden.

1. Bei der einfacheren Variante wird die Wahlberechtigung während der Wahl ausschließlich anhand dieses Geheimnisses geprüft, d.h., falls das Geheimnis gültig ist und damit noch keine Stimme abgegeben wurde, so wird die zusammen mit dem Geheimnis verschickte verschlüsselte Stimme gespeichert und später ausgezählt. Da außer der Wählerin/dem Wähler selbst niemand die Zuordnung zwischen ihm/ihr und Geheimnis kennt, wird die Anonymität sichergestellt. Problematisch ist bei dieser Form die aus praktischen Gründen manchmal erforderliche Entfernung von Wahlberechtigten aus dem Wählerverzeichnis während der Wahl. Dies ist faktisch nicht möglich, da die Geheimnisse anonym gespeichert sind.
2. Die einfache Variante der vorgelagerten Wähleridentifikation wurde daher in der Weise erweitert, dass im ersten Schritt das Geheimnis an einen Wahlberechtigungsserver geschickt wird, der die Wahlberechtigung anhand des Geheimnisses und ggf. weiterer Daten überprüft und dem Wähler/der Wählerin dann ein zweites anonymes Geheimnis zuschickt, das er/sie zur berechtigten Stimmabgabe am Urnen-Server vorweisen muss. Neben dem Einsatz bei der GI-Wahl wird diese Variante auch bei den Projekten in Genf und Zürich verwendet.

Für die Sicherstellung der Anonymität ist die Geheimhaltung der Zuordnung von Geheimnis und Wähler/Wählerin erforderlich. Damit ist die Lösung keine rein technische, sondern verlangt auch organisatorische Maßnahmen.

Systeme mit verdeckter Auswertung

Bei Systemen mit verdeckter Auswertung handelt es sich um Verfahren, bei denen die einzelne Stimme nicht entschlüsselt wird, ihr Besitzer aber bekannt ist und nur die Summe über alle Stimmen gebildet und dann das Wahlergebnis entschlüsselt wird. Durch diesen Verfahrensablauf gelten die Systeme als besonders nachvollziehbar und werden deshalb bei Wahlen eingesetzt, bei denen die Stimmabgabe über mehrere Kanäle möglich ist.

Diese Eigenschaft wird in der Praxis durch zwei verschiedene Wege realisiert – entweder durch den Einsatz von Hardware Security Modules (HSM) oder durch homomorphe Kryptographie:

1. HSM werden zur Wahrung der Anonymität in der Weise eingesetzt, dass die verschlüsselten Stimmen im HSM decodiert und ausgezählt werden, aber nicht einzeln, sondern nur in ihrer Summe ausgelesen werden können. Solch ein System kam bei den Lokalwahlen in Estland im Herbst 2005 zum Einsatz.
2. Eine kryptographische Funktion E gilt dann als homomorph, wenn folgende Regel gilt: $E(T_1) \times E(T_2) = E(T_1 + T_2)$. Dann braucht man zur Wahlauswertung nur die verschlüsselten Stimmen miteinander zu multiplizieren, denn das Produkt entspricht dem verschlüsselten Wahlergebnis $T_1 + \ldots + T_n$. Durch diese Eigenschaft können die Stimmen gezählt werden, ohne eine einzelne Stimme zu kennen. Das bekannteste Protokoll wurde von Schoenmakers [12] vorgestellt und war Basis des EU CyberVote Projekts.

Die Sicherstellung der geheimen Wahl beruht bei diesen Verfahren darauf, dass die Auszählung tatsächlich verdeckt erfolgt.

Systeme mit blinder Signatur

Diese Online-Wahl-Verfahren basieren im Wesentlichen auf dem von Chaum bereits 1981

vorgestellten Verfahren zur blinden elektronischen Unterschrift [1]. Chaums Verfahren kann mit dem Einsatz eines Blaupapierkuverts verglichen werden. A will von B eine Unterschrift, ohne dass B den Inhalt des zu unterschreibenden Dokuments kennt. Dazu steckt A das Dokument in das Blaupapierkuvert, versiegelt es, übergibt es B zur Unterschrift. Dieser unterschreibt auf dem Kuvert, die Unterschrift drückt sich durch die Blaupapierfunktion auf das Dokument durch und gibt das Kuvert an A zurück. A öffnet das Kuvert, entnimmt das Dokument, das nun die authentische Unterschrift von B besitzt, ohne dass dieser das Dokument gesehen hat. Setzt man diese Technologie bei Wahlen ein, so werden zwei Varianten unterschieden: Entweder lässt sich der Wähler/die Wählerin den geblendeten Stimmzettel von einer Stelle elektronisch unterzeichnen, um die Stimme dann anonym an eine andere Stelle schicken zu können (wie in [5]), oder das blind signierte Dokument ist ein anonymes Pseudonym (wie in [9]), welches dem Wähler/der Wählerin dann erlaubt, seine/ihre Identität von seinem Stimmzettel zu lösen.

Anforderungen an die Anonymisierung

Neben den hier vorgestellten drei Varianten zur Wahrung der Anonymität in der Stimmabgabe gibt es zahlreiche weitere Vorschläge. Ihnen gemein ist, dass sie zumeist nur Teilprobleme lösen oder auf einen spezifischen Einsatz abzielen. In der Praxis gilt es aber auch, neben der tatsächlichen Erfüllung der geheimen Stimmabgabe, das Vertrauen der Wähler in das Verfahren zu gewinnen. Dies gelingt nicht allein durch mathematische Beweise, sondern vielmehr durch eine anschauliche Darstellung der Ergebnisse und durch eine möglichst hohe Analogie mit herkömmlichen Verfahren, da diese bereits in der Praxis bewährt sind und daher Vertrauen genießen.

Sicherheit am Endgerät

Der Wähler muss zur Stimmabgabe mit dem Endgerät (in der Regel ein PC) auf die Wahl-Server zugreifen können, um seine Stimme dort abzugeben. Es existieren verschiedene Ansätze für die Gestaltung der *Client-Software* des Online-Wahl-Systems, die sich bzgl. Sicherheit, Kosten und Benutzerfreundlichkeit unterscheiden und im Anschluss diskutiert werden.

Client-Software

Für die Realisierung der Client-Software gibt es vier Varianten: 1. kann sie als reine Webbrowser-Lösung, 2. durch einen Rich-Client, 3. durch ein Wahlbetriebsystem und 4. durch ein eigenes Endgerät realisiert werden.

Unter einer reinen *Webbrowser-Lösung* versteht man den Einsatz einer Online-Applikation, die ohne zusätzliche Programme wie Applets, Java Script oder ähnlichem auskommt. Es ist daher die kostengünstigste und benutzerfreundlichste Möglichkeit, Wählern die Online-Stimmabgabe zu ermöglichen, da sie über den beim Wähler bereits installierten Browser erfolgt. Die Kommunikation wird dabei über SSL abgesichert. Bei der Webbrowser-Lösung entfallen alle Protokollansätze, die Berechnungen auf Seiten des Wählers vorsehen. Übrig bleiben daher nur noch Systeme, die sich auf vorgelagerte Wähleridentifikation verlassen (siehe Abschnitt „Systeme mit vorgelgerer Wähleridentifikation“). Die Einfachheit geht einher mit der Übernahme der Verantwortung für die technische und organisatorische Sicherheit durch die Wahlverantwortlichen. Es muss den einzelnen Wahl-Servern vertraut werden, dass sie nicht zusammen arbeiten, um die Wahl zu manipulieren oder das Wahlgeheimnis zu brechen.

Um sämtliche Protokollansätze umsetzen zu können und damit die technische Sicherheit zu erhöhen, werden so genannte *Rich-Clients* beim Wähler eingesetzt. Die Stimmabgabe selbst, sowie verschiedene mathematische und kryptographische Berechnungen erfolgen über eine Wahlsoftware. Einen *Rich-Client* lädt der Wähler aus dem Internet herunter oder erhält ihn auf CD beispielsweise mit der Post oder an öffentlichen Stellen und installiert ihn auf seinem Rechner. Die Erhöhung der technischen Sicherheit wirkt sich einerseits negativ auf die Benutzerfreundlichkeit und andererseits auf die Kosten aus, denn Implementierung und Verteilung werden teuer.

Bei der dritten Variante soll der Wähler eine CD mit einem Knoppix-artigen *Wahlbetriebssystem* ausgehändigt werden, mit der er seinen PC bootet, um seine Stimme abzugeben. Auf diese Weise kann eine erheblich höhere Sicherheitsstufe erreicht werden. Aus Kostengründen sowie wegen der Benutzerfreundlichkeit ist dieser Ansatz aber problematisch: Zum einen entstehen wesentlich höhere Entwicklungskosten (das Betriebssystem muss auf allen PCs einsetzbar sein und eine Verbindung

zum Internet herstellen können) und zum anderen muss das Betriebssystem verteilt werden.

Die letzte Variante lässt sich nur bei kleinen Wählerzahlen umsetzen, da hier jedem Wähler ein *spezielles Wahlgerät* ausgehändigt wird, das die eigentlichen wahlspezifischen Berechnungen wie Verschlüsseln sowie Signieren übernimmt und den PC nur zur Übertragung der Daten an das und aus dem Internet verwendet. Diese Variante bietet zwar ein Maximum an Sicherheit und wäre bzgl. der Benutzerfreundlichkeit akzeptabel, ist aber aus Sicht der entstehenden Kosten nur selten in die Praxis umsetzbar.

Zusatzmechanismen gegen bösartige Software

Da aus Kostengründen und für die Benutzerfreundlichkeit in der Praxis keine 100% sichere Client-Lösung eingesetzt werden kann, gilt das Endgerät als schwächstes Glied in der Sicherheitskette, da auf ihm bösartige Software installiert sein kann. Daher muss ihm besondere Beachtung geschenkt werden. Bösartige unentdeckte Software auf dem Endgerät kann automatisch und unbemerkt großen Schaden anrichten und die Wahlrechtsgrundsätze verletzen: Die Stimme des Wählers kann beispielsweise durch ein Trojanisches Pferd zwecks Stimmenkauf (*freie Wahl*) oder um das *Wahlgeheimnis* zu brechen vor dem Verschicken an den Wahlserver zusätzlich an eine dritte Person übermittelt werden. Die *allgemeine* Wahl kann verletzt werden, indem die Malware dem Wähler vorgibt, seine Stimme am Wahlserver abgegeben zu haben, obwohl diese nie dorthin verschickt wurde. Die auf dem Endgerät installierte Malware kann auch dergestalt programmiert sein, dass die *freie* und *gleiche* Wahl verletzt ist. Die Software könnte hierzu die Stimme vor dem Abschicken verändern. Auf diese Weise kann im großen Stil das Wahlergebnis unbemerkt und automatisch manipuliert werden.

Als Gegenmaßnahmen bieten sich drei Varianten an:

1. Eine Möglichkeit ist, dem Wähler *Hilfestellungen* bei den Sicherheitseinstellungen seines Rechners zu geben. Dies kann beispielsweise in Form einer leicht verständlichen Handreichung geschehen, wie dies bei der GI-Wahl der Fall war.
2. Ein ähnlicher Ansatz kann in Form eines „*automatischen Sicherheitschecks*“ durch die Wahlsoftware erfolgen. Dabei wird vor dem Start der eigentlichen Stimmabgabe das Endgerät auf Malware untersucht.
3. Mit der *Verschleierung der tatsächlichen Stimme* beschäftigen sich die Ansätze von Bernard van Acker [13] und von Gerald Fischer und Wolfang Zuser [3]. Bei ihren Ansätzen wird nicht die eigentliche Stimme verschickt. In van Ackers Vorschlag ist für die Software nicht ersichtlich, ob die Stimme, die gerade verschickt wird, auch die ist, die gezählt wird, oder nur eine Fake-Stimme. Dazu schickt der Wähler dem Server ein zusätzliches zuvor vereinbartes Geheimnis mit, mittels dem der Server entscheiden kann, ob die Stimme gespeichert oder als Fake-Stimme verworfen werden kann. Bei Fischer und Zuser erhält der Wähler zusätzlich zu seinen bisherigen Wahlunterlagen eine eindeutige Zufallszahl (einen Modulo-Wert) und eine mit Hilfe dieser Zahl permutierte Kandidatenliste. Der Wähler entscheidet sich nun für einen Kandidaten und gibt die zugehörige Kandidatenzahl in der Wahlsoftware ein. Der Wahlserver kann dann am Ende anhand der Zuordnung der eindeutigen Zufallszahl und der zugehörigen Kandidatenpermutation den eigentlichen Kandidaten extrahieren und das Ergebnis berechnen. In beiden Fällen kann die Malware auf dem Endgerät keine gezielte Manipulation mehr vornehmen. Es findet allerdings eine Verlagerung der Bedrohungen statt, denn das Offenlegen der jeweiligen Zuordnungsliste ist seinerseits sicherheitskritisch.

Verantwortung des Wählers

Die Sicherung des Endgeräts ist eine wesentliche Voraussetzung für eine sichere Wahl. Da sie aber im Einflussbereich des Wählers selbst liegt, muss dabei auch Verantwortung an den Wähler abgegeben werden. Um dies zu ermöglichen, muss ein Höchstmaß an Unterstützung in Form von hoher Benutzbarkeit, niedrigen Kosten und einfachen Handlungsanweisungen an den Wähler geboten werden.

Dabei darf auch nicht vergessen werden, dass die Wahlverantwortlichen alle in ihrem Einflussbereich liegenden Maßnahmen (automatischer Sicherheitscheck durch die Software etc.) einsetzen sollen, die eine größtmögliche Sicherheit auf der Seite des Wählers gewährleisten können.

Optimale Sicherheit

Bei dem Design eines Online-Wahl-Systems muss immer die Sicherheit an vorderster Stelle stehen. Die hier vorgestellten Mechanismen reichen einzeln für sich nicht aus, um den ordnungsgemäßen Ablauf einer Online-Wahl sicher zu gewährleisten. Erst der kombinierte Einsatz der Methoden macht eine Online-Wahl zu einer sicheren Wahl. Auch wenn damit nie eine 100%ige Sicherheit erreicht werden kann, so ist damit zumindest eine *optimale Sicherheit* erreichbar. Und wenn man sich die Papierwahl in der Praxis ansieht, stellt man fest, dass auch hier keine 100%ige Sicherheit gegeben ist.

Wahltests und rechtsgültige Wahlen in Deutschland

Es wurden in Deutschland in den vergangenen sieben Jahren 41 Online-Wahlen und davon 22 rechtsgültig durchgeführt. Ein Überblick über diese durchgeführten Wahlen findet sich in Tabelle 2 des Anhangs. Damit zählt Deutschland zweifellos neben der Schweiz, Großbritannien und Estland zu den europäischen Vorreitern.

In den letzten sieben Jahren wurden damit über 200 000 Stimmen online abgegeben. Der große Boom ist 2001 zu verzeichnen. Nur 5% der Wähler haben ihre Stimme dabei rechtsgültig abgegeben und 95% bei einem Wahltest. Auffallend ist, dass die Anzahl der Stimmberechtigten bei Wahltests viel größer ist als bei rechtsgültigen Online-Wahlen. Ausnahmen bilden die Wahl des Betriebsrates der T-Systems (1777 Stimmen) und die beiden GI-Wahlen (4845 bzw. 4030 Stimmen). Die Übersicht hebt auch die beiden bekanntesten deutschen Systeme hervor. Zum einen das *Polyas* System der Firma Micromata GmbH, das bereits erstmals 1997 in Finnland in einer Schule bei einem Wahltest zum Einsatz kam. Zum anderen das *ivote*-System, dessen erste Ideen bereits für das Wahlspiel 1998 implementiert wurden. Dieses wurde erst von der Forschungsgruppe Internetwahlen und dann im Rahmen des Projekt W.I.E.N. weiter entwickelt. Derzeit wird das *ivote*-System von der Stiftung Internetwahlen betreut. Das W.I.E.N. Projekt wird heute von T-Systems weitergeführt, um darin nun das *T-Vote* System zu entwickeln. Die Wahlen mit dem *Polyas* System zeichnen sich vor allem durch die großen Wählerzahlen aus, wogegen mit *ivote* bereits mehrere Wahlen mit unterschiedlichen Authentifizierungstechniken durchgeführt wurden.

Zur Authentifizierung wurde bei 22 der Wahlen Wahl-PINs oder Wahl-Passwörter eingesetzt und bei 11 Online-Wahlen kamen Chipkarten zum Einsatz. Nur ein einziges Mal wurde mit biometrischen Merkmalen gearbeitet. Homomorphe Verfahren kamen ebenfalls nur ein einziges Mal zum Einsatz. Dagegen halten sich blinde Signaturen (17) und vorgezogene Anonymisierung (19) die Waage.

Die zahlreichen durchgeführten Online-Wahlen zeigen, dass letztendlich nicht die eingesetzte Technik als solche verantwortlich für das Ausbleiben eines Durchbruchs von Online-Wahlen via Internet ist, denn sowohl alle Arten der Authentifizierungstechniken als auch alle Anonymisierungsmechanismen wurden in unterschiedlichen Systemen eingesetzt. Daher sind die Hindernisse auf einer anderen Ebene zu suchen.

Schlussfolgerung und Handlungsempfehlungen

Der Beitrag bietet einen breiten Einblick in die Thematik und Problematik von Online-Wahlen – insbesondere für den Standort Deutschland. Er spiegelt die Erfahrung der letzten 20 und insbesondere der letzten sieben Jahre wider, die gezeigt haben, dass es sich um ein hochkomplexes und interdisziplinäres Thema handelt (vgl. Abb. 1).

Neben den in diesem Artikel vorrangig angesprochenen technischen und juristischen Aspekten werfen Online-Wahlen auch verschiedene soziologische und politologische Fragestellungen auf. Politische Diskussionspunkte betreffen neue komplexere Wahlformen und den Weg zur direkten Demokratie mit einer Vereinfachung des Wahlvorgangs durch den Einsatz von Online-Wahlen. Die Aufgabe von Soziologen ist es zu untersuchen, wie *Junk Vote* vermieden werden kann und ob sich die

Abb. 1 Dimensionen von Online-Wahlen

Wahlbeteiligung und das Wahlverhalten durch die Einführung von Online-Wahlen verändert.

Viele der angesprochenen Fragestellungen können und sollen von den einzelnen Experten der vier Disziplinen parallel bearbeitet und erforscht werden. Generell muss aber jede Disziplin eine Grundvorstellung der Probleme der anderen Disziplinen haben. Einige Fragestellungen sind nur gemeinsam zu bewältigen, so vor allem die Erstellung einer Online-Wahlverordnung, die technische Anforderungen, die die juristischen Vorgaben ausdrücken, enthält.

Abschließend ist festzustellen, dass derzeit die ersten Früchte der zahlreichen Forschungsarbeiten der vergangenen Jahre geerntet werden können. Um jedoch flächendeckend rechtsgültige Online-Wahlen erfolgreich in Gremien, Vereinen, Verbänden und ähnlichen Organisationen durchführen zu können, sind weitere Arbeiten erforderlich. Hierzu liefert die Gesellschaft für Informatik e.V. einen entscheidenden Beitrag durch die Einrichtung der Expertengruppe mit Erfahrungen aus vielen Sicherheitsbereichen sowie dem Wahlgeräteumfeld, die die Durchführung der GI-Wahl als Online-Wahl begleitet und untersucht hat. Ein weiterer wichtiger Punkt ist die Erstellung und Zertifizierung eines Protection Profiles nach CC für Online-Wahlen in Gremien und Vereinen, um die sich auf dem Markt befindenden Online-Wahl-Systeme vor dem Einsatz nach allgemein anerkannten Regeln und Vorgehensweisen von unabhängigen Gutachtern prüfen zu können.

Hierdurch sind wir auf dem besten Wege, die erste Stufe des beispielsweise von Kubicek in [7] vorgeschlagenen schrittweisen Vorgehens zu erreichen, und können uns dann in einem weiteren Schritt staatlich geregelten Wahlen wie Betriebs- und Personalratswahlen widmen. Hierbei muss zunächst über die Art der Online-Wahl und das Authentifizierungsmerkmal entschieden werden, um die entsprechenden Verordnungen aus Gremienwahlen anpassen zu können. Bis hierher wird es aber noch einige Zeit dauern – aber die Entwicklung dahin scheint unaufhaltsam zu sein.

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Anhang – Übersicht der in Deutschland durchgeführten Wahlen

Tabelle 2

Deutsche Online-Wahlen im Überblick[a]

Name	Software	Jahr	Wahlform[b]	Authentifikation[c]	Anonymität[d]	Wahlbeteiligung	Zahl an teilnehmenden Wähler	Recht
Wahlsimulation „WK 329“	ivote	1998	R	–	B	–	17.000	☐
Vereine und Verbände	Wolff	1999	R	S	V	–	–	☐
TK Sozialwahl	ivote	1999	R	S	B	72%	1.000	☐
Studierendenwahl Osnabrück	ivote	2000	R&K	O	B	38%	356	☑
Personalratswahl LDS Brandenburg	ivote	2000	R	O	B	59%	329	☐
Abstimmung Mensaessen FH Hannover	FFH-Internetw@hl	2000	R	S	V	3%	150	☐
Studierendenwahl FH Hannover	FFH-Internetw@hl	2000	R	S	V	68%	220	☑
Virtueller Parteitag	Brokat	2000	R	S	V	100%	110	☑
Jugendgemeinderatswahl Esslingen	ivote	2001	–	O	B	–	34	☑
Komm'Un'W@hl des BDKJ Niedersachsen	ivote	2001	K	–	B	–	–	☐
neXTvote – ivote Landesjugendring Niedersachsen	ivote	2001	K	–	–	–	–	☐
Jugendgemeinderatswahl Fellbach	D-Trust, i-kom	2001	R&K	S	V	27%	444	☑
Jugendgemeinderatswahl Bobenheim-Roxheim	D-Trust, i-kom	2001	R&K	S	V	–	54	☐
Landratswahl im Kreis Marburg-Biedenkopf	KIV Hessen, Berminger Software, D-Trust	2001	R	S	–	–	–	☐
Hochschulwahl Universität Bremerhaven	ivote	2001	R&K	O	B	–	117	☑
Wahl zur Seniorenvertretung in Köln	Integrata (heute Unilog)	2001	K	S	–	–	–	☐
Jugendgemeinderatswahl Filderstadt	i-kom	2001	R&K	S	V	20,61%	354	☑
Personalratswahl LDS Brandenburg	ivote	2002	K	O	B	72%	385	☑

Tabelle 2

Fortsetzung

Name	Software	Jahr	Wahlform[b]	Authentifikation[c]	Anonymität[d]	Wahlbeteiligung	Zahl an teilnehmenden Wähler	Recht
Juniorwahlen zur Bundestagswahl	Polyas	2002	K	S	V	86%	58.000	☐
Betriebs- und Aufsichtsratswahl Webasto	ivote	2002	–	B	B	–	–	☑
Betriebsrat T-Systems CSM	ivote	2002	R&K	SO	B	–	1.777	☑
Betriebsrat der ivl GmbH	ivote	2002	–	–	–	–	–	☐
SPD-Parteitag Bochum	T-Vote	2003	K	–	B	–	–	☐
	T-Vote	2003	K	O	B	3%	3	☑
D21 Vorstandswahl	Polyas	2003	R	O	V	51%	54	☑
Hochschulwahlen Bremen	EUCyberVote	2003	K	O	H	20%	47	☑
Juniorwahlen zur Landtagswahl in Hessen	Polyas	2003	K	S	V	84%	5.800	☐
Juniorwahlen zur Landtagswahl in Bremen	Polyas	2003	–	–	V	88%	7.200	☐
Städte- und Gemeindebund Brandenburg	T-Vote	2004	K	S	B	–	270	☑
WSIS-Regierungsdelegation	GPL-WahlSW von Alvar Freude	2004	R	S	V	83%	30	☑
Gesellschaft für Informatik	Polyas	2004	K	S	V	24%	4.845	☑
Digitale Brücken	mimox-vote	2004	R	SO	–	100%	10	☑
Juniorwahlen zur Landtagswahl in Thüringen	Polyas	2004	K	S	V	86%	5.400	☐
Juniorwahl zur Landtagswahl in Brandenburg	Polyas	2004	K	S	V	83%	7.800	☐
Juniorwahlen zur Europawahl (Deutschland)	Polyas	2004	K	S	V	84%	42.000	☐
Sprecherausschusswahl – T-Systems international	T-Vote	2005	R	O	B	–	–	☑
Vorstandswahlen des Weimarer Kreises	ivote	2005	K	O	B	–	–	☑
Außerord. Betriebsratswahl – T-Systems international	T-Vote	2005	R	O	B	–	–	☑
Juniorwahlen zur Bundestagswahl 2005	Polyas	2005	K	S	V	90%	45.000	☐

Tabelle 2

Fortsetzung

Name	Software	Jahr	Wahlform[b]	Authentifikation[c]	Anonymität[d]	Wahlbeteiligung	Zahl an teilnehmenden Wähler	Recht
Betriebsratswahlen								
T-Systems (Nordbayern)	T-Vote	2005	R	S	B	–	–	☑
D21 Vorstandswahl	Polyas	2005	R	S	V	55,3%	57	☑
Gesellschaft für Informatik	Polyas	2005	R	S	V	20,1%	4.030	☑

[a] Die Tabelle inklusive Literaturangaben zu den einzelnen Projekten befindet sich auf der Seite http://www2.dfki.de/fuse/index.php?option=com_content&task=view&id=26&Itemid=42.onlinewahlenDeutschland.html, abgerufen am 28.11.2005.
[b] In dieser Spalte wird entsprechend dem Kapitel „Wahlformen" die eingesetzte Wahlform angegeben. Neben der reinen Remote-Online-Wahl wurden auch Wahlen mit Online-Wahl am Kiosk aufgenommen. Die Notation wird wie folgt verwendet: *R* bedeutet Remote-Online-Wahl, *K* bedeutet Online-Wahl am Kiosk, *R&K* ist die Kombination aus Remote-Online-Wahl und Online-Wahl am Kiosk.
[c] In dieser Spalte wird entsprechend dem Kapitel „Wählerauthentifizierung" die verwendete Art der Anonymisierung angegeben: *S* bedeutet: der Wähler erhält eine Wahl-TAN, *O* bedeutet: der Wähler hat oder erhält eine Chipkarte, *B* bedeutet: Wählerauthentifizierung mittels biometrischer Merkmale.
[d] In dieser Spalte wird entsprechend dem Kapitel „Anonymintät der Stimmabgabe" die verwendete Art an Anonymisierung angegeben: *V* entspricht der vorgelagerten Identifizierung, *H* entspricht der verdeckten Stimmauszählung, *B* entspricht der Pseudonymisierung mit blinden Signaturen.

Article III

Edelmann, Noella, **Robert Krimmer** and Peter Parycek. 2008. "Engaging Youth through Deliberative e-Participation: A Case Study." *International Journal of Electronic Governance* 1(4), 385-399. (1.2)

As a fundamental principle of democracy, participation in the broader sense includes engagement in acts of representative democracy, such as communication with politicians and political parties, elections, and opinion formation. This paper analyzes a case study from Austria, which aimed to encourage young people to participate in political discussions. The results show that the young people were interested in online deliberation and that it is a method of participation that they will accept and will actually use. The paper identifies that any form of e-participation must be accessible and usable to all those interested as well as capable of motivating other citizens to take an interest in political matters.

Engaging youth through deliberative e-participation: a case study

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Abstract: The Austrian e-participation project "mitmachen.at – move your future", looked at young people involved in an online public discussion. Results from this case study show that there is interest in online deliberation and is a method of participation which is both accepted and will be used by young people. The participants expressed optimism: they want this form of participation to be made possible and results to be made available to politicians. Their criticism and feedback must be used both to improve the services offered and motivate citizens to take an interest in political and civic issues.

Keywords: e-participation; e-democracy; good practice; Austrian youth participation; four-phase participation; online deliberation; reusable case studies; novel standardisation approaches; case study.

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1 Introduction: e-democracy in Austria

As a fundamental principle of democracy, participation in the broader sense includes engagement in acts of representative democracy such as communication with politicians and political parties, elections and opinion formation (including e-campaigning, interactive virtual 'polling booths' such as www.politikkabine.at in Austria and http://wahlkabine.at/eukabine for the EU).

Public participation in its different forms can be legally institutionalised in all three governmental powers: for example, petitions for a referendum in legislation, lay judges and juries in jurisdiction, and in large-scale administration projects which require official approval (as can be seen with planning laws or building regulations). Beside these regulated forms, there are various types of informal participation to be found, particularly in public administration, where individuals and lobby groups are engaged in projects, regional planning and developments in the public sector.

Democracy in its various forms has increased since World War II, and although this has led to increased stability and peace (UNDP, 2002), voter turnout is decreasing (Pintor and Gratschew, 2002), which could be interpreted as an indicator for a democratic crisis. In Austria, turnout is still high in comparison to other countries, but is starting to decrease here too. The younger generations are less interested in traditional party politics, long-established organisations and institutions, and the political establishment in general. Younger people prefer spontaneous, temporary forms of involvement (Hafeneger et al., 2005; Hurrelmann, 2006).

Ideas about using new technologies for participation date from the 1960s. Scientists from various fields provided the first concepts and projects, but there were problems concerning the access technologies and usability. Since 1994, with the rapid spread of the internet, numerous changes have taken place in the private and public sectors, and although technology has changed business processes and public life, e-democracy still remains a vision. Traditional politics are resistant to fundamental changes, and the last years have seen a number of projects, with varying degrees of success, provide alternative approaches. Technological progress, citizen e-consultation, and participation projects may lead to cooperative democracy, but these are neither strategies nor concepts capable of covering the different forms and methods of participation. Hibbing and Theiss-Morse (2002) state that there are two issues which need to be considered: stakeholders who are afraid of losing their power, and maybe, the theory that citizens do not want to see democracy in practice and do not want to be involved in politics is true after all.

Beside the top-down aspects, 'democratisation' also means including the non-governmental fields. 'Civic participation', in the broadest sense, includes Business-to-Government (B2G), Citizen-to-Citizen (C2C), Citizen-to-Business (C2B) and NGO activities, political and/or social commitment such as honorary posts, spontaneous e-activism and e-mobilisation. It is, therefore, a bottom-up approach which addresses both national and international institutions. Bottom-up participation is usually informal, initiated and/or carried out by individuals, temporary citizen action groups or organised civil society groups, e.g., NGOs, trade unions and religious communities. Many initiatives are started by political parties or organisations from the third sector close to the state and then outsourced, as is the case with youth associations. In addition, there are other initiatives based on internal information and communication channels (e.g., the Intranet), which are C2C and can be found within other bodies including management boards and industry.

Given these fluid boundaries, the starting point of (e-)democratic processes – in Austria, for example, consultative referenda and plebiscites can only be initiated top-down – is less crucial than the agenda setting. Public administration can take up movements occurring at grass-roots level and suggestions from the population (using, for instance, complaint management), then implement an informal participation process: in some Austrian provinces, the results of provincial youth parliaments are treated as petitions. Ideally, a state that activates its citizens should aim to empower them to act from the bottom-up.

In 2006, the "Working Group for e-democracy and e-participation" was founded by the Austrian Federal Chancellery with the aim of collecting e-participation projects in Austria and developing a policy. The first project overview revealed that there are a number of activities in the area of youth (e-)participation.

In Austria, 95% of the 14–18-year-olds use the internet; so online-based participation projects are possible as long as they are made accessible to everyone. A common prejudice is that young persons are not interested in politics at all, yet a survey by Serloth and Maerki (2004) reveals that 86.7% of all adolescents do want to be involved in political decisions, and 92.5% believe that political engagement is beneficial to their personal development, although only 50.9% are actually willing to contribute towards such activities. Whilst 25.4% of them know about any youth programmes, only 15% participate. This shows that there is a big discrepancy between the value given

to participation and the actual level of engagement, particularly in traditional or party politics.

Young people have very advanced skills in using the new technologies and they want to be involved; on the basis of these assumptions, the first web-based Austrian-wide youth e-participation project was initiated.

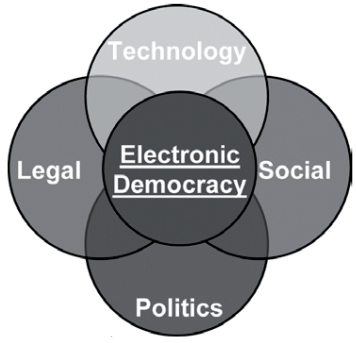
2 Electronic democracy and electronic participation

The concept of electronic democracy dates back to the time of the Second World War; mainly positive visions that had little or no connection to the emergence of the internet. Visionaries such as Fromm (1955), Fuller (1963), Arterton (1987) or Rheingold (1993) believe that the internet affords new, more direct forms of democracy, but there are also opposing views, as held by Golding (1996) or Haywood (1995), that foresee a more negative effect on democracy due to unequal access to information. Others, such as Leggewie and Bieber (2001) or Bimber (2001), believe that the internet will have no effect at all on democracy. Given the still small number of e-democracy instruments presently available, it is hard to find evidence for any of the positions and opinions held. Still, these assumptions play a very important role when it comes to the judging politicians.

Electronic democracy is often seen in a close relationship to electronic government. Some definitions describe e-democracy as a subject matter of its own; other definitions describe it as a part of e-government. Scholl (2002), for example, defines electronic government as "the use of information technology to support government operations, engage citizens and provide government services", thereby including electronic administration and electronic participation by citizens. This differentiation can also be found in Europe, where von Lucke and Reinermann (2004) distinguish between e-workflows and e-democracy.

Although the information technology used is similar to that in e-commerce, e-participation involves the legal and social components found in electronic government (Reinermann and von Lucke, 2000) and is a political activity, making it even more complex. This leads to the four dimensions of e-democracy (see Figure 1).

Figure 1 The four dimensions of e-democracy (own illustration)



Von Lucke and Reinermann (2004) define e-democracy as the electronic representation of the democratic processes, which Parycek (2005) divides into three sub-processes:

i information acquisition

ii opinion formation

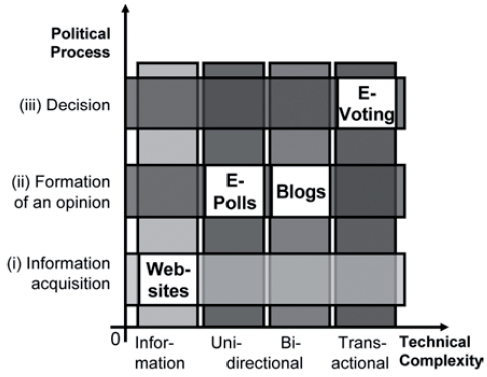
iii the decision itself.

Electronic democracy has, therefore, often been understood as having two aims – e-participation (decision preparation, i.e., the processes (i) and (ii)) and e-voting (decision making, i.e., process (iii)). This separation implies that e-voting focuses on using existing instruments (and is, therefore, highly disputed) and e-participation focuses on the new, deliberative forms of e-democracy instruments. This distinction is not helpful – it would be better to develop a unified model that fits both applications. A further dimension that needs to be considered is the level of technical complexity. It is the combination of all the dimensions that can lead to a single e-democracy application framework. This framework follows an approach developed by the EU's e-democracy working group (Macintosh, 2003) where political processes are matched with the technical complexity.

This leads to four application types (depicted in Figure 2):

- websites, which provide information to citizens
- e-polls, which are uni-directional, as citizens do not receive any feedback on their opinion
- blogs, which represent a discussion, and finally
- e-voting, where a decision is ultimately taken.

Figure 2 Framework of e-democracy instruments (own illustration)



3 Methodology

A case-study is a method which involves an in-depth study of a contemporary phenomenon using multiple sources of evidence in its real-life context. The context of the

case-study is essential, as understanding the dynamics present within the setting of the case study is of particular relevance (Eisenhardt, 1989; Bonoma, 1985).

Exploratory research is a type of case-study that will often be used when there are few theories or only little knowledge is available about the area being investigated. According to Yin (2003), exploratory research has the following characteristics:

- The research aims to explore certain phenomena and to understand the context in which the phenomenon takes place.
- The research does not begin with an initial set of questions and/or notions within which the study will take place.
- Multiple methods may be used for collecting the data – these can be quantitative or qualitative.

Hussey and Hussey (1997) argue that "these characteristics are open to debate", and it depends on what paradigm the researcher decides to use, making it possible to conduct a case study using a strong(er) theoretical foundation and specific research question(s). A number of other investigative methods can also be used in a case study, including documentary analysis, interviews or observation.

4 The case-study mitmachen.at

The project aimed to gain new insights into the development and implementation of e-participation instruments, so the exploratory case study approach was selected. The case study methodology provides what Bassey (1981) describes as a "three-dimensional picture and will illustrate relationships, micro-political issues and patterns of influences in a particular context".

This methodology was chosen as it provided the researchers with the opportunity to investigate a particular instance of online deliberation. The case study was to allow the exploration of the facilitating and mitigating factors of a successful e-participation instrument experiment. The case study design followed three phases:

- define and design
- prepare, collect, and analyse
- analyse and conclude (Yin, 2003).

Adopting the case-study approach meant that it was possible to concentrate on a specific instance of e-democracy and to, therefore, analyse the various interactive processes – according to Bell (1999)

> "the great strength of the case-study method is that it allows the researcher to concentrate on a specific instance or situation and to identify … the various interactive processes at work. These processes may remain hidden in a large-scale survey but may be crucial to the success or failure of systems or organizations." (Bell, 1999, pp.10, 11)

Using the case study methodology also allowed the researchers to identify the particular features, strengths and weaknesses of a specific instance of online deliberation and, therefore, also provided information for conducting future projects and defining the

potential prospects for e-democracy. Obviously, there is the danger of distortion; the researchers selected the instance to be investigated, the material to be presented and the form of presentation. With this particular case-study, the knowledge gained can be used for future work in this area, as the data was obtained on the significant features (Denscombe, 1998), the evidence was collected systematically and critically structured, leading to details which are sufficient and appropriate (Bassey, 1981).

The focus of the study was online participation, participant involvement, the relationships that developed between participants (the posting threads were made using pseudonyms or anonymously) and, at a meta-level, how participants felt about online participation. No concrete research questions were set, as the aim of the study was to analyse the project and its results as a whole, to show the opportunities and limitations of online deliberation as a means of increasing citizen engagement and reducing the problem of citizen apathy, as described by Blumler and Coleman (2001) or Klein (1999). The lessons learned from this instance of online deliberation will be used for future projects (described in the last section of this paper).

Investigating a case study requires stating and defining the "single unit of analysis, such as an event, a process or even an individual" (Hussey and Hussey, 1997). Kervin (1992) suggests that the unit of analysis has to be set at a level as low as possible, i.e., the level where decisions are taken. The mitmachen.at target group was chosen as the unit of analysis, as it represents an example of e-democracy at work. Using Kervin's terminology, in this case-study, the unit of analysis used was an *aggregate*, defined as a "collection of undifferentiated individuals or bodies with no internal structure". This unit of analysis was chosen rather than *a body of individuals* (which according to Kervin includes groups of people and organisations), as the target group was defined as young Austrians, but it was

- not possible to ensure that only young people participated (participation was anonymous)
- the definition of a 'young person' varies according to different definitions and choice of criteria
- being a citizen is not being a member of an organisation as such.

The target group were young citizens aged 15–25 living in Austria. The participants were asked to give their opinions and make suggestions on particular issues relevant to their future. The target group was reached using a number of different channels, including e-mails directed at pupils in all secondary schools (all grades), and information about the project was disseminated by youth institutions, state education authorities, IT-teachers, the school-IT organisation 'Education Highway', Austrian job centres (AMS Arbeitsmarktservice) and the Austrian Ministry of Education, Department of Political Education.

A reference framework based on the model in Figure 1 was used for the analysis of data. First, the actual participative process was analysed at the micro-level, then, in a second step, the strengths and weaknesses of the approach are discussed.

An interesting aspect in this case study is that due to the nature of constitutional law, which varies from country to country on the basis of their national histories, democratic instruments can be very different and political online participation in different countries can be similar in nature, yet may use very different procedures. The opportunity to study

national mechanisms may lead to the discovery of cross-national similarities and provide information for future international projects.

Case study research has a number of weaknesses, such as setting the boundaries to the phenomenon or deciding on the setting to be investigated. The phenomenon does not exist in its own vacuum, which means that is important to be aware of its context and setting; the case study will have a history and a future which influences the present interpretation and understanding of the events which take place in it. Hussey and Hussey (1997) even suggest that "You may find it difficult to understand the events in a particular period of time without knowledge of what went before and what may follow". The project mitmachen.at showed that the results obtained must be interpreted and understood by looking at the societal context and the media in particular – any political discussion is embedded in the context in which it is being held.

5 mitmachen.at – move your future: getting young people to e-participate

For democratic political processes to function, there needs to be a relationship and dialogue between politics and citizens, and citizens must actually participate in the democratic process (van Lerberghe, 2007). The project mitmachen.at – move your future, is a youth e-participation project led by the Austrian Federal Computing Centre (BRZ, Bundesrechenzentrum) with the aim of getting young people to participate in a political discussion about topics they deem to be important for their future. In Austria, 90.8% of adolescents believe in the value and importance of their participation, but only 25.4% actually know how to participate (Serloth and Maerki, 2004). The name of the project reveals the objective: in German, the verb 'mitmachen' means 'to join in', 'to participate', and the project was to provide young citizens aged 15–25 and living in Austria with the opportunity to use the internet to participate in a 4-step process which allows them to present and voice their concerns about the future.

In Austria, mitmachen.at was one of the biggest e-participation projects, and the BRZ worked with a number of organisations including youth institutions, software companies, various Think Tanks and the relevant public authorities to develop a democratic participation process. The project brought a number of interesting results and conclusions, but the actual project itself proves that "e-participation represents a cross-sectional subject, which can be part of a procedure on its own, but could also be useful in many other areas of application" (Piswanger, 2007).

The project was to investigate and test the general electronic participation processes, but it also looked at the technical implementation and the (technical) framework which make such participation processes possible. Portals are important for simplifying the vertical and horizontal integration of e-government (Moon, 2002), and the virtual portals used for this project included both the necessary instruments for participation as well as two different user levels (administrative and end-user).

5.1 The four phases of the project mitmachen.at

The four e-participation phases (based on a model developed by Piswanger (2004)) in the project were:

- information and communication
- analysis
- validation
- publication.

These four phases provided the participants with a schedule and an outline of what they were required to do, and, at the same time, ensured the transparency of the project. The project mitmachen.at was the first e-participation project to add the fourth phase, publishing the results and making them available to political actors (all results are still available on the website www.mitmachen.at).

Phase 1: Information and communication

The information and communication phase provided participants with a time frame (schedule) and informed them about the steps required in the participation process. The project followed a top-down approach: the discussion topics were provided at the beginning and provided moderator support (if deemed necessary). The topics used for discussion in the first phase of the project are the results from the study 'Österreich 2050' (Mahrer, 2006) which is based on 2500 interviews. The eight topics used for the online-discussion were: environment, health, education, security, infrastructure, social system, political system, employment.

During this first phase, participants were asked to rate (1st step) the topics, then provide their own opinion (2nd step):

Step 1: The pupils rated the importance of each of the eight topics on a 1–4 scale (very important – not important), thus determining the four topics they believed to be most important for their future in Austria. 763 ratings were obtained, and the results showed that, for the participants, the four most important topics were environment, employment, education and health. This initial result is, in itself, not so important, rather, this first step ensures that participants familiarise themselves with the content to be discussed.

Step 2: During the second step, participants had the opportunity to develop their own ideas and to contribute suggestions concerning any of the eight topics. 2079 contributions were made, the majority of them (1424) were then included into the second phase of the project and analysed (approximately 20 discriminatory/racist remarks were excluded).

The two steps meant that participants knew what topics would be discussed and would have formed opinions about them prior to the validation phase (phase 3). The moderator had an important role: ensuring a minimum quality of the contributions (e.g., by ensuring that comments were not off-topic; by clarifying issues or answering questions; providing information) and censoring contributions which were either racist, sexist, rude or used foul language.

The majority of comments were made in the category 'political system', and revealed the participants' frustration with politics and politicians. A few wanted to know more about the Austrian political system and politics but, in general, the comments were derisive and very superficial.

Many comments and suggestions were made for the topics: environment, health and education. Pollution and the protection of the environment were generally important for all participants, but more specific contributions were made in the other topics: education (quality of teaching, language skills and subjects available in schools) and health (hospital staff, alternative medicine).

The discussion process was governed by the eight topics, but the participants had the opportunity to voice their opinions about anything else they considered to be important. A small number of participants displayed interest in the project itself, the results to be obtained from the project and how opinions and results would be used. A participant declared: "The politicians should read this …".

Phase 2: Analysis

The analysis phase involved a panel of experts who were responsible for the evaluation of the contributions made by the participants. The members of the expert panel came from universities, research and public institutions, and met 28 November – 14 December 2006 to evaluate the contributions. An academic advisory board supported the expert panel to ensure the validity of the project.

All the contributions made by the participants to the four most important topics were to be evaluated using a semantic IT program which categorised and weighted the words. The program looks at the frequency of the words, analyses the synonyms and the relationship between the words, and then produces a graphic representation of the participants' contributions. The use of such a program is justified (and valid) when more than 1000 contributions are made. In the project mitmachen.at, the small number of contributions made to the four most important topics did not allow for a graphic representation, so the panel of experts relied on their own expertise and manually categorised the contributions made by the participants. On the basis of the contributions, the expert panel (see phase 3) provided 174 concepts which the participants evaluated in the next phase, validation.

Phase 3: Validation

The expert panel's 174 concepts were posted on the project website, and during the third phase (15 December 2006 – 31 January 2007), participants could rate and evaluate them. For the project mitmachen.at, the evaluation was made using online questionnaires, and during the time frame provided, 2578 questionnaires were completed and returned.

The topic seen as most relevant and important was 'environment' and received 396 nominations. The results show what issues are particularly important to young people in Austria, including employment for young people, classes taught at school, the quality of teachers, young people's health (in particular weight and anorexia), police training, human rights, personal safety issues, single mothers, alternative energy and protecting the rainforests. At the same time, the results also reveal what is presently considered to be less important, such as issues related to the political system, although the participants did show interest in the tools which may be necessary for democracy to work. Disinterest in politics is typical for young people in Austria (Serloth and Maerki, 2004), and only people over 20 years of age start to show a greater interest in this topic – this requires great consideration when deciding what age group(s) such projects should address.

Some of the topics which received a higher rating were in the media (for example, school systems, drugs, smoking bans, immigration, the acquisition of the Eurofighter-airplanes, unemployment, ageing society, pollution) and discussed at

educational, societal and political levels. But the results from this validation process do provide a catalogue of measures which can be used as a working paper in a political discussion. The results were made public and available in the next phase, publication.

Phase 4: Publication

This is the last phase, and began on 1 February 2007: the results and experiences obtained from the study were presented in a parliamentary press conference to the public. The results were made available on www.mitmachen.at and sent to the relevant political and administration departments as well as youth representatives.

5.2 Project conclusions

The results show that this is a method of participation which is accepted and will be used by young people. Particularly, the concepts developed in the second phase, analysis, can be evaluated as being successful as they provide a "mini-governmental program determined by young Austrians" (as described by a member of the expert panel). The target group is interested in being involved and participating in validation processes, and a greater number of participants can be reached by using more information channels and timing the participation process to the target group's needs (in this particular project, it was timed to the school year). A marketing strategy encouraging young people to participate needs to look at what channels they really like and use, so they can be reached directly, encouraged to participate and contribute to the discussion. This strategy must also have a specific definition of the category 'young people', i.e., decide what the age bracket/limit should be – the Austrian Census Office, for example, defines a youth as a person up to 19 years of age. The age bracket plays an important role as certain topics may more be interesting for older participants, as is clearly the case with politics. The age bracket has to be considered carefully, as a participation project geared towards younger participants may be inappropriate for older participants. The language used on the portal also has to be age appropriate – the language and terms used for older participants may not be appropriate or understood by younger participants, and they may, therefore, not understand what they are required to do. Other issues which should also be considered are education, employment, literacy, digital divide and accessibility.

The project mitmachen.at followed a top-down approach, and the discussion topics were given to the participants at the beginning. The aim was to keep the participants' discussion focused on the topics and prevent them from talking about issues which may not have any relevance to political deliberation and the mitmachen.at aims. This approach directs the participants' focus of attention and sets boundaries on their 'exploration' of a topic, but at the same time, it obviously reduces the variety of opinions and the number of discussions. Although the top-down approach does not influence the actual form and procedure of participation, it may distort how participants really feel about and rate certain topics. The project mitmachen.at did not let the participants go beyond the 174 concepts developed by the expert panel, and may have therefore produced results which do not really represent the participants' real feelings and opinions. It also means that any topics not considered by the research team were not included. The concepts developed by the expert panel may furthermore reveal more about the experts' opinions on the topic and may also have 'blinkered' the participants by leading them to focus more on certain topics rather than letting them explore the topic on their own and using their own language and wording. A bottom-up approach which adopts technologies such as

online surveys, online polls, online voting, online referenda and online discussion boards is usually resisted by political actors as it allows for criticism and oppositional voices. But these approaches are expected in participatory systems: the internet enables many-to-many-communication, networked debates and participants want to use the technology available to change organisations and society, include others (Fuchs, 2006).

The third phase, validation, showed that the environment is a popular and important topic, but it has to be noted that during the course of project, the ORF (Österreichischer Rundfunk, the Austrian public broadcasting corporation) was showing a number of TV-programs about climate change. There may be a correlation between the TV-programs and the high number of ratings the topic environment received during the third phase of the project, so participatory processes must always be evaluated, analysed and understood in the context of the media.

The results obtained were positive, although is it clear that better timing with the school year would have generated more discussions and greater involvement. The moderation of the contributions was considered to be successful as censorship was not really necessary (only 20 contributions were excluded as they included defamatory and racist remarks) and only a small number of moderator interventions were necessary to clarify issues or comments made by the participants. The size of the discussions and the involvement determines whether semantic tools are necessary or not.

This project showed that there is interest in online deliberation and the internet certainly offers a new possibility of involving citizens in political discussions. E-participation represents citizen participation and presents the real challenge for future e-democracy: given the possibility and the means, citizens will get involved, but they need to overcome scepticism, which can be reduced by ensuring that political actors obtain the results from their online participation and discussions. The means of participation must be adapted to the target group characteristics, for example, younger citizens may need age-appropriate language, and immigrants may require simpler language or the possibility to participate in their own language (or by providing translation services). In this project, no young people were involved in the project other than as participants (a criticism voiced by the participants themselves too, see below), which could have avoided certain problems, by providing information about age-appropriate language and the use of technical terminology, or advising on how to reach a wider number of participants and a better timing of the project. Citizens and political/public actors have a wide range of media and ICT tools to assist them with complex processes such as participation, but they must be able to

> "enhance representative democracy, whilst creating a vibrant, inclusive, transparent and responsive Knowledge-based Democratic Society and not just be a new form of political communication." (van Lerberghe, 2007)

With hindsight, the mitmachen.at project showed that involving young people throughout the project would have been very valuable, and is a lesson learned for future projects. The participants themselves voiced the criticism that the expert panel had one social scientist but did not include any teachers, students, school representatives or young people. This is a very important point, as the expert panel should have involved young people to ensure both its' own and the project's credibility. The fact that the expert panel did not have any young people enforced the top-down approach of the project as well as a 'we' vs. 'them' mentality. Some participants expected censorship and expressed disbelief

that results from this particular e-participation project and generally any participation processes would be taken seriously at the political level. Although van Lerberghe (2007) states that "while citizens are not alienated to politics and the life of their communities, they are more and more distrusting their mainstream representatives" the participants still expressed optimism: they want this form of participation to be made possible, they want such projects to be politically supported, and the results to be made available to politicians.

6 Outlook

At the beginning of 2007, the Austrian parliament reformed the voting laws: beside the new possibility of postal voting and e-voting, the voting age was reduced to 16 years. Political education is more important than ever before, and adolescents must be well informed in order to be able to take good decisions. It is well known that political education needs to include a practical approach; so, beside the right to vote, youth participation programmes should encourage young people to engage in politics. Public administration also needs a policy and guidelines for online citizen participation; in Austria, there are numerous projects at the planning stage which will be launched in the coming months, and an e-democracy policy and strategy is to be established by the end of 2008.

This policy will include standardised e-participation methods, including the four-phase model, as it can be used for a wide range of participation projects ranging from local, neighbourhood projects to nation-wide involvement. Standardisation and reusability are important issues for a number of reasons:

- it is easier for public administration to build on the experience of successful methods
- every completed project leads to further improvement
- citizens get accustomed to certain formats and procedures
- using existing platforms brings financial advantages and projects can be initiated quickly and with greater ease.

The aim of developing a policy is not to regulate participation, but to provide an overview and a documentation of tested methods, as well as allowing further innovation.

At the beginning of 2008, the Austrian-wide project 'jugend2help.gv.at' was started. In this project, young people were invited to openly and anonymously let the public administration know which information and services they expect to receive and how it should be presented. This project included the following new aspects:

- For testing reasons, the duration of the phases was increased.
- The expert panel categorised the contributions manually rather than using semiautomatic semantic programs.
- The expert panel included young people.

- Some features were more user-friendly, e.g., the capture-page displays provided greater accessibility since the needs of blind people were taken into consideration. Since the internet and e-based methods increase the chances for people with disabilities to participate in politics, special efforts were made to provide good accessible solutions.

More Austrian projects will be launched in 2009, and the coming years will show the extent to which citizens want to become politically involved and make use of the new technologies for this purpose. All in all, we will soon know if technology can actually change democracy.

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Article IV

Helbach, Jörg, **Robert Krimmer**, Nils Meissner, Anastasia Meletiadou and Melanie Volkamer. 2007. "Zukunft von Online-Wahlen – Aktuelle rechtliche, politische, soziale und technisch-organisatorische Fragen." *Datenschutz und Datensicherheit* 31(6), 434-440. (1.2)

At the beginning of the millennium, several projects commenced with the aim to allow voting via the Internet. After the first set of experiences, it became clear that one has to answer a number of legal, political, social and organizational questions to master the technical challenges. This paper explains which areas must be regulated in the legal domain, how voters can trust technical systems, and the implications that remote electronic voting has on politics and democracy.

DuD
Datenschutz und Datensicherheit

Zukunft von Online-Wahlen

Aktuelle rechtliche, politische, soziale und technisch-organisatorische Fragen

Jörg Helbach, Robert Krimmer, Anastasia Meletiadou, Nils Meißner, Melanie Volkamer

Die Umsetzung elektronischer Wahlsysteme ist eine interdisziplinäre Aufgabe, bei der neben den technischen vor allem auch politische, gesellschaftliche und juristische Anforderungen zu erfüllen sind. Der vorliegende Beitrag zeigt offene Fragestellungen in den Disziplinen Recht, Gesellschaft und Politik auf. Er ist ein Gemeinschaftsprojekt von der ersten Arbeitstagung E-Voting in D/A/CH in Saarbrücken von 27.-29. Oktober 2006.

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Einleitung

Elektronische Wahlen im Allgemeinen und Online-Wahlen im Speziellen sorgen seit Anfang der achtziger Jahre zwischen Verfechtern und Gegnern immer wieder für kontroverse Diskussionen. Während die einen in der elektronischen Stimmabgabe die Zukunft unserer Informationsgesellschaft sehen, stellen sich die anderen auf den Standpunkt, dass das jetzige System hervorragend funktioniert und sehen daher keinen Änderungsbedarf. Ganz im Gegenteil, sie halten die elektronische Stimmabgabe für einen Verstoß gegen die geltenden Wahlgesetze. Dass beide Gruppen zahlreiche Anhänger haben, zeigt sich auf der einen Seite durch die ständig wachsende Zahl der durchgeführten Online-Wahlen, z.B. in Deutschland die Wahlen der Gesellschaft für Informatik e.V. und die Wahlen und Referenden in der Schweiz und in Estland, und auf der anderen Seite die steigende Anzahl der Gruppen, die sich gegen den Einsatz von Wahlgeräten wehren (z.B. in Frankreich mit Recul-Democratique, in Irland die Vereinigung „Irish Citizens for Trustworthy Evoting“ und in den Niederlanden die Stiftung „Wij vertrouwen stemcomputers niet“[1]), sowie vereinzelte erste Klagen, wie etwa bei der Bundestagswahl in Deutschland im vergangenen Jahr. Einige Befürworter von Online-Wahlen denken, dass diese neuen Wahlformen sogar mehr Sicherheit, vor allem aber mehr Wahlkonformität für den Wähler bei der Stimmabgabe bieten könnten. Beispielsweise kann ihm der Weg zum Wahllokal erspart werden und das System kann ihn gerade bei komplizierten Verfahren auf ungültige Stimmen hinweisen.

Allerdings ist die Entwicklung von Online-Wahlsystemen noch nicht weit genug fortgeschritten, um damit parlamentarische Wahlen durchführen zu können. Der vorliegende Beitrag zeigt die wesentlichen Kritikpunkte und listet offene Fragestellungen der Disziplinen Recht, Gesellschaft und Politik auf.

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[1] http://www.wijvertrouwenstemcomputersniet.nl/

Erich Schmidt: B 90 x H 251

1 Recht und Technik

Bisher wurden bereits zahlreiche Online-Wahlen und Online-Wahltests durchgeführt. Dennoch sind Online-Wahlen kaum in bestehende Gesetze und Verordnungen integriert worden. Ausnahmen bilden die Gesellschaft für Informatik e.V. (GI)[2], die Initiative D21, die Schweiz[3] und das LDS Brandenburg in Form einer Erprobungsklausel in der Wahlordnung.

Um über Online-Wahl-Tests hinaus zu kommen, müssen diese jedoch in die entsprechenden Regularien integriert werden, beispielsweise in die Wahlordnungen für Betriebs- und Personalrats- sowie Universitäts- oder Sozialwahlen. In den folgenden Abschnitten wird erörtert, wie eine solche Integration erfolgen kann und welche Probleme dabei im Detail auftreten könnten.

1.1 Integration von Online-Wahlen in Regularien

Die Integration von Online-Wahlen in bestehende Regularien gestaltet sich unterschiedlich schwierig und ist kontextabhängig. Beispielsweise definiert jeder Verein seine Satzung und damit seine Wahlordnung selbst, wogegen einer Firma die Einführung neuer Wahlformen beispielsweise bei der Wahl des Betriebsrats nur dann möglich ist, wenn das Betriebsverfassungsgesetz entsprechend geändert wird. Dies erfordert mehr Aufwand, da eine Gesetzesänderung einen entsprechenden demokratischen Willensbildungs- und Entscheidungsprozess voraussetzt. Ähnlich schwierig ist es bei Personal- und Sozialwahlen oder gar bei parlamentarischen Wahlen.

Es existieren verschiedene Ansätze, um Online-Wahlverfahren in die bestehenden Wahlregularien zu integrieren. Der einfachste Weg stellt ein Zusatzparagraf dar, der besagt, dass jedes elektronische Wahlverfahren eingesetzt werden darf, das genauso sicher ist, wie das jetzige, traditionelle Wahlverfahren. Das hieße, dass das elektronische Wahlsystem so zu entwickeln ist, dass alle bisherigen Anforderungen nachweislich erfüllt werden. Hierbei stellt sich zunächst die Frage, wie geprüft werden kann und soll, dass ein elektronisches Ver-

[2] http://www.gi-ev.de/wir-ueber-uns/leitung/wahlen-und-ordnungen

[3] http://www.bk.admin.ch/themen/pore/evoting/00777

fahren diese doch eher juristisch und weniger technisch formulierten Anforderungen erfüllt. Darüber hinaus wurde u.a. in [KrVo05] gezeigt, dass elektronische und Papierwahlen nicht die gleiche Sicherheit aufweisen, sondern beide Verfahren ihre Vor- und Nachteile haben. Daher sollte ein anderer Ansatz verfolgt werden.

Alternativ könnten, analog zur Bundeswahlgeräteverordnung [BWahlGV], die bestehenden Gesetze und Regelungen um neue erweitert werden, die die Verwendung elektronischer Wahlen behandeln. Eine solche E-Voting-Verordnung müsste die organisatorischen und technischen Anforderungen an das elektronische Wahlverfahren regeln. Bei der Verwendung zertifikatsbasierter Verfahren wären beispielsweise dabei die Verantwortlichkeiten für die Prüfung, Zertifizierung und den Widerruf von Zertifikaten festzulegen.

1.2 Wie erstellt man eine Online-Wahl-Verordnung

Die Entwicklung einer E-Voting-Verordnung muss auf der Basis der bestehenden Regularien und grundsätzlichen Anforderungen erfolgen. Grundlage für eine neu zu entwickelnde Verordnung sind daher die bereits bestehenden Wahlgesetze. Darüber hinaus dürfen die bereits im Grundgesetz § 38 Abs. 1 verankerten Wahlrechtsgrundsätze nicht verletzt werden: „Die Abgeordneten des deutschen Bundestages werden in allgemeiner, unmittelbarer, freier, gleicher und geheimer Wahl gewählt."

Da die für jedermann verständliche Wahl mit dem Papierstimmzettel durch ein komplexes technisches System ersetzt wird, ist ein interdisziplinäres Team zur Erarbeitung der E-Voting-Verordnung unabdingbar. Zwar verstehen die Juristen genau ihre rechtlichen Anforderungen und die Techniker ihre Wahlsysteme und -protokolle und deren mögliche Sicherheitsfunktionen, aber um eine reibungsfreie Kommunikation zu ermöglichen und Konflikte zu vermeiden, muss zunächst zwischen allen Beteiligten ein gemeinsames Verständnis der Zusammenhänge und Anforderungen gefunden werden. Denn rechtliche, organisatorische und technische Anforderungen haben alle ihre Berechtigung, können aber nicht isoliert von einander betrachtet werden.

Neben dem Bundesinnenministerium (zuständig für die BWahlGV) haben sich auch schon einige andere Arbeitsgruppen Gedanken gemacht, wie man die rechtlichen Anforderungen unter Verwendung von technischen Terminologien formulieren könnte. Beispiele hierfür sind die Empfehlungen des Europarates [CoE04], der Anforderungskatalog der Physikalisch-Technischen Bundesanstalt [PTB04] und das Protection Profile für Online-Wahlen, das in einer Zusammenarbeit zwischen dem Bundesamt für Sicherheit in der Informationstechnik (BSI), dem Deutschen Forschungszentrum für künstliche Intelligenz (DFKI) und der GI entstanden ist.

Im Folgenden wird aufgezeigt, dass es bezüglich einiger der geforderten Anforderungen noch Diskussionsbedarf gibt, da die Erfüllbarkeit einzelner Anforderungen durch die Technik von der Interpretation der entsprechenden Anforderungen abhängt.

Der Konflikt zwischen Technik und Recht im Bezug auf E-Voting ist bereits seit einigen Jahren bekannt. Die ersten Punkte, die diskutiert wurden, sind (siehe hierzu [Will02]): die Gleichheit der Wahl versus der Anzeige des Stimmzettels auf unterschiedlichen PC oder gar Handy-Bildschirmen, die Allgemeinheit der Wahl versus der Tatsache, dass nicht alle Wähler Zugang zum Internet haben (Digital Divide) oder nicht alle Endgeräte vom eingesetzten Wahlsystem unterstützt werden, sowie die Diskussionen über einen Ungültig-Button bzw. Warnhinweise im Falle einer ungültigen Stimmabgabe. Darüber hinaus haben sich im Laufe der Jahre weitere Diskussionspunkte herauskristallisiert, die im Folgenden dargestellt werden.

1.2.1 Dauerhafte Geheimhaltung der Stimme

Aus rechtlicher Sicht ist klar gewollt, dass eine Stimme dem Wähler auch in der Zukunft (zumindest aber bis zu seinem Tod) nicht zugeordnet werden kann. Dem entsprechend verunsichert sind Juristen über Artikel wie [UKK01, VoKr06], in dem erklärt wird, dass diese Forderung von den meisten Online-Wahlsystemen nicht erfüllt werden kann. Hintergrund ist, dass die eingesetzte Verschlüsselung nicht informationstheoretisch sicher ist und damit nicht ausgeschlossen werden kann, dass jemand in der Zukunft in der Lage ist, im Netz mitgelesene Stimmen zu entschlüsseln und einem Wähler zuzuordnen. Um entscheiden zu können, ob die Verfahren dennoch akzeptabel sind und ob man den Wahlrechtsgrundsatz der geheimen Wahl etwas weiter fasst, sollten sich Sicherheitsexperten und Juristen zusammensetzen und sich gegenseitig die Problematik erklären. Denkbar wäre hier auch, dass das BSI, ähnlich wie beim Signaturgesetz, Empfehlungen über die Stärke der zu verwendenden Verschlüsselungsalgorithmen abgibt.

1.2.2 Zufällige Reihenfolge der Kandidaten versus Gleichheit der Wahl

In der technisch versierten Online-Wahl-Community wird immer mehr die Problematik des Einsatzes von Standard-PCs bei Wahlen diskutiert. Kritiker von Online-Wahlen sehen hier eine der größten Schwachstellen, da Malware auf dem Rechner des Wählers entweder die Stimmabgabe mitlesen kann und damit das Wahlgeheimnis gebrochen wird, oder die Stimme vor der Stimmabgabe unbemerkt ändern kann, um so das Ergebnis zu manipulieren (siehe [Vo06] für eine ausführliche Diskussion). In der Zukunft wird der Einsatz von Trusted Computing dieser Gefahr entgegenwirken. Solange diese Technik aber noch nicht ausgereift genug ist, schlagen Experten vor, die Reihenfolge der Kandidaten zufällig zu mischen (siehe z.B. [Ry05, Fi05]) oder den Wähler nur eine „zufällige" Kandidatennummer eingeben zu lassen. Auf diese Weise kann auf dem PC installierte Malware mit den gesammelten Daten nicht auf die Kandidatenwahl schließen und kann durch Veränderungen an den Werten keine gezielte Manipulation der Wählerstimme durchführen. Damit ist eine Manipulation aber nicht grundsätzlich ausgeschlossen; auch führen diese technischen Vorschläge zu rechtlichen Bedenken, da die Stimmzettelgestaltung für jeden Online-Wähler unterschiedlich ist. Insbesondere unterscheidet sie sich von einem Papierstimmzettel. Aus juristischer Sicht ist damit der Wahlrechtsgrundsatzes der Gleichheit der Wahl verletzt.

1.2.3 „Separation of Duty"-Eigenschaft

Das Vertrauen in das traditionelle Wahlverfahren fußt im Wesentlichen auf der Tatsache, dass alle Parteien Wahlhelfer stellen, die sich in ihrer Tätigkeit im Wahllokal gegenseitig kontrollieren (Separation of Duty). Hier stellt sich nun die Frage, ob und wie diese Möglichkeit in ein elektronisches Wahlverfahren migriert werden kann. In der Regel sind elektronische Wahlsysteme derart komplex, dass die Überprüfung und Überwachung durch den Wähler nicht sinnvoll möglich ist. Diese Aufgabe muss daher von Fachexperten übernommen werden, denen der Wähler vertrauen muss. Zusätzlich müssen die Wahlhelfer in der Lage sein das Wahlsystem zu starten, zu

stoppen und vor allem auf korrekten Ablauf hin zu überprüfen. Da dies ebenfalls Expertenwissen erfordert, muss der Wahlvorstand im Wahllokal ggf. durch technische Erfüllungsgehilfen erweitert werden. Hierbei ist dann eine genaue Definition der Aufgabenverteilung und der Weisungsberechtigung erforderlich.

1.2.4 Freiheit der Wahl versus Vote Updating

Ein weiteres Problem von Online-Wahlsystemen ist das der Quittungsfreiheit. Ein Wähler soll nach Möglichkeit überprüfen können, dass seine Stimme korrekt in der Urne angekommen ist. Gleichzeitig darf er aber nicht in der Lage sein, seine Wahlentscheidung zu beweisen. Damit soll Stimmenkauf ausgeschlossen werden. Da es sich hierbei, zumindest teilweise, um konkurrierende Anforderungen handelt, müssen entsprechende Lösungen gefunden werden. Ein Ansatz ist die Einführung von Vote Updating [SW02, VoGr06]. Dabei kann ein Wähler seine Wahlentscheidung „überschreiben", indem er seine Stimmabgabe wiederholt. Das Wahlsystem stellt sicher, dass jeweils nur eine Stimme in das Wahlergebnis einfließt. Der Einsatz von Vote Updating hat den weiteren Vorteil, dass eine Beobachtung des Wählers im privaten Umfeld bei der Stimmabgabe uninteressant wird. Juristen sehen hier Probleme hinsichtlich der Gleichheit der Wahl sowie dem Verlust des Wahlwertes, wenn man seine Stimme beliebig oft verändern kann.

1.2.5 Transparenz und Verständlichkeit versus Sicherheit

Wie oben bereits erwähnt ist für den Erfolg eines Wahlsystems insbesondere dessen Transparenz, Nachvollziehbarkeit und Überprüfbarkeit entscheidend. Nur wenn diese Punkte gegeben sind, kann der Wähler dem Wahlsystem vertrauen.

Einen ersten Ansatz zur Erhöhung der Transparenz für den Wähler liefern bei Wahlmaschinen sog. „Voter Verified Audit Trails". Dabei wird die Wahlentscheidung eines Wählers auf Papier ausgedruckt, sodass dieser den Ausdruck überprüfen und in eine Urne einwerfen kann. Dies hat den Vorteil, dass das Wahlergebnis durch die Auswertung dieser zusätzlichen Urne nachgezählt werden kann. Dieses Verfahren ist offensichtlich aber nicht auf Online-Wahlsysteme übertragbar.

1.2.6 Öffentlichkeit bei der Auszählung

Es steht heute allen Wählern frei, die korrekte Durchführung der Wahl im Wahllokal zu beobachten. Dazu gehören die Möglichkeit der Überprüfung der leeren Urne vor der Wahl, die Beobachtung des Wahllokals während der Wahl und insbesondere die öffentliche Auszählung der abgegebenen Stimmen nach der Wahl. Es ist offensichtlich, dass dieses Verfahren nicht direkt auf elektronische Wahlsysteme übertragen werden kann. Dass die Verletzung dieses Öffentlichkeitsprinzips auf große Kritik stößt, zeigt u.a. die Anfechtung der letzten Bundestagswahl.

Ein Lösungsansatz dieser Problematik könnte sein, dass die elektronische Wahlurne unter Zuhilfenahme verschiedener Systeme unabhängig voneinander ausgezählt wird. Ein anderer ist der digitale Wahlstift, den die Stadt Hamburg einsetzen möchte, bei dem man bei Zweifeln auf die Papierstimmen zurückgreifen und diese auszählen kann.

1.2.7 Wahlbeobachtung bei Online-Wahlen

Wahlbeobachtung ist ein wichtiges Element bei vielen Arten von Wahlen, vor allem im parlamentarischen Umfeld. Die Wichtigkeit von Wahlbeobachtung wird bei einer Einführung von Online-Wahlen aufgrund der fehlenden Transparenz steigen. In diesem Zusammenhang stellen sich die Fragen, wie die Wahlbeobachtung von Online-Wahlsystemen ermöglicht wird und wie dies in die Regularien zu integrieren ist. Eine wichtige Rolle in diesem Zusammenhang spielen die Auditdaten, die das System erzeugt: was soll überprüft werden und wie sind die Daten auszuwerten? Das Wahlsystem sollte über Mechanismen verfügen, die eine Beobachtung der Wahl auch durch einen Technik-Fremden ermöglichen [KrVo06].

1.3 Einheitliches Vorgehen bei der gesetzlichen Einbindung

Offensichtlich besteht Forschungs- und Diskussionsbedarf, um Online-Wahlen in die bestehenden Regularien einzubinden. Diese Integration sollte nicht nur für die jeweilige Wahlform und –art erfolgen, sondern das Thema allgemeiner betrachten und daher auch andere Formen und Arten sowie Wahlen auf anderen Stufen und Ebenen berücksichtigen. Momentan ist jedoch ein Trend zu erkennen, dass die Wahlorganisatoren, die Online-Wahlen einsetzen wollen, sich ihre eigene Lösung für die Integrität, für die Anforderungen und eine Überprüfung überlegen. An dieser Stelle wäre eine Vernetzung wünschenswert, um Gemeinsamkeiten der verschiedenen Konzepte zu finden und einen gemeinsamen Kern zu erarbeiten, auf dem dann jede Wahlorganisation, in Abhängigkeit vom Kontext, aufbauen kann.

2 Soziale Aspekte

Die nähere Betrachtung von elektronischen Wahlen wirft – über technische und rechtliche Aspekte hinaus – zahlreiche andere Fragestellungen auf. Hier sind beispielsweise das Vertrauen in die Verfahren, die Akzeptanz in der Praxis und die Benutzbarkeit der Systeme zu diskutieren.

2.1 Vertrauen in die Verfahren

Geht man von der aktuellen Diskussion aus, so kann vermutet werden, dass Experten und informierte Nutzer von elektronischen Wahlverfahren zurzeit wenig Vertrauen in solche Systeme haben. Die Gründe für das fehlende Vertrauen können vielfältig sein. Einige davon werden im Folgenden diskutiert.

2.1.1 Mangelnde Transparenz des Wahlverfahrens

Wie im ersten Abschnitt bereits angedeutet, ist ein Problem die mangelnde Transparenz der elektronischen Wahlverfahren. Im Unterschied zu dem klassischen Verfahren, in dem die Bürger die Möglichkeit haben, das Verfahren der Wahl und das Zustandekommen der zugehörigen Ergebnisse selbst (auch wenn dafür diverse organisatorische Schritte und das vertraute Medium Papier benötigt werden) nachzuvollziehen, sind die Funktionsweise und die Ermittlung der Ergebnisse bei der Verwendung von elektronischen Wahlmaschinen bzw. Online-Wahlen für die Allgemeinheit nicht ohne weiteres überprüfbar.

Um die Verwendung von elektronischen Wahlverfahren ernsthaft betreiben zu können, reicht es nicht aus, wenn nur Fachleute die Funktionsweise verstehen und überprüfen können. Insbesondere wenn sich Experten vor allem kritisch zu den von ihnen untersuchten Systemen äußern, kann das Vertrauen der Bürger in diese Systeme sinken.

Daher sollten Strategien und Methoden gefunden werden, wie Bürger entweder über die elektronischen Wahlverfahren informiert werden können oder – noch besser – selbst in die Lage versetzt werden, sich einen Einblick in die entsprechenden Mechanismen zu verschaffen.

Eine Möglichkeit diese Thematik in das Bewusstsein der Allgemeinheit zu rücken, könnten z. B. Testwahlen oder die Etablierung in weniger sensiblen Bereichen (im Gegensatz zu Bundestagswahlen) sein. Dabei sollten dem Wähler folgende Punkte erläutert werden:

- Wie funktioniert das Verfahren auf abstraktem Niveau genau?
- Wie wird dabei gewährleistet, dass die Prinzipien von freien, geheimen und gleichen Wahlen eingehalten werden? Wie wird beispielsweise sichergestellt, dass jede abgegebene Stimme korrekt gezählt wird, aber gleichzeitig verhindert, dass jemand herausfinden kann, wie eine bestimmte Person abgestimmt hat?
- Wie kann man das Ergebnis nachträglich verifizieren?

2.1.2 Fehlende Offenlegung der technischen Systeme

Ein weiterer Grund für begründetes Misstrauen ist die fehlende Offenlegung der technischen Systeme. Experten haben wiederholt die Geheimhaltung der technischen Details kritisiert. Sie verweisen darauf, dass so der Eindruck entstehen könnte, dass entweder die Systeme gar nicht sicher sind und dies verschleiert werden soll oder die Verantwortlichen (Hersteller, Politiker) kein Interesse daran haben, diese Transparenz herbeizuführen.

Hier wird beispielsweise angeführt, dass die Offenlegung der technischen Details eine Kompromittierung der Systeme durch Angreifer erleichtern würde und daher durch Geheimhaltung bekämpft werden könne. Diese „security by obscurity“ wird jedoch von anderer Seite kritisiert. Eine wirkliche Sicherheit könne nur erreicht werden, wenn die Mechanismen zum Zweck der Überprüfung offen gelegt werden. Außerdem könnten durch Forschungsaktivitäten auf Basis von Open-Source-Quellcode verbesserte Verfahren entwickelt werden.

In diesem Zusammenhang ist auch die Zertifizierung der Systeme durch entsprechende Organisationen zu sehen. Momentan werden die Systeme zwar durch zuständige Behördenstellen untersucht, aber weder das genaue Zertifizierungsverfahren, noch der detaillierte Bericht dazu sind für die Allgemeinheit zugänglich [Sie06]. Hier wäre konkret an öffentlich dokumentierte Security-Audits durch anerkannte Institutionen zu denken.

2.1.3 Wie viel Vertrauen ist hinreichend?

Im Gegensatz zum bisher geforderten Streben nach möglichst großem Vertrauen in das Verfahren und die Technologie ist abzuwägen, wie weit die Bemühungen nach Transparenz und Nachvollziehbarkeit getrieben werden sollen. Ab wann sind elektronische Wahlen als hinreichend sicher anzusehen, so dass die Bürger der Technologie und den Verfahren vertrauen können?

Man denke hier an andere elektronische Verfahren, wie etwa beim Onlinebanking oder bei Geldautomaten. Auch diese verwenden Sicherheitsmechanismen, die zwar ein gewisses Sicherheitsniveau herstellen, aber keine perfekte Sicherheit bieten. Gründe dafür sind beispielsweise in der Abwägung mit wirtschaftlichen Interessen, der Praktikabilität, der Bequemlichkeit der Benutzer, im fehlenden Interesse der Banken oder der verspäteten Einführung von verbesserten Verfahren zu sehen. Trotzdem werden diese Verfahren anscheinend von einem Großteil der Kundschaft als ausreichend sicher angesehen oder zumindest – trotz etwaiger Bedenken – in der Praxis eingesetzt.

Für die Einführung von elektronischen Wahlverfahren kann erwartet werden, dass ähnliche Effekte eintreten. Bei der „nicht-perfekten“ Sicherheit ist genau zu überlegen, welcher Anteil davon guten Gewissens akzeptiert werden kann (eine perfekte Absicherung gibt es prinzipiell nicht; es ist nur möglich, ein bestimmtes Sicherheitsniveau zu erreichen; siehe auch Abschnitt 1.2.5) und welcher Anteil davon nicht akzeptabel ist, weil er nur durch falsche Gründe (z. B. wirtschaftliche Interessen der Hersteller) motiviert ist.

Bei dieser Diskussion und der Abwägung zwischen angestrebtem Sicherheitsniveau und dem dafür notwendigen Aufwand ist auch zu berücksichtigen, dass es sich bei dem zu schützenden Gut, nicht um einige Tausend Euro auf einem Girokonto sondern die grundsätzliche Absicherung von zentralen demokratischen Grundrechten handelt, die – anders als im Falle eines Bankensystems – nicht durch einfache Haftung geregelt sind.

2.2 Akzeptanz in der Praxis

Betrachtet man die Akzeptanz elektronischer Wahlverwahren in der Praxis sind über das Vertrauen in das Verfahren hinaus einige weitere Themen zu diskutieren.

2.2.1 Wirtschaftliche Aspekte

Die Bürger wären vielleicht bereit, sich an ein neues System zu gewöhnen, wenn sie einen finanziellen Vorteil für die Allgemeinheit erkennen könnten. Hier sind etwa folgende Fragestellungen zu untersuchen:

- Wie viel würde die Ausstattung der Wahllokale mit Wahlmaschinen kosten? In Deutschland gibt es immerhin rund 80.000 Wahllokale.
- Wie viele von diesen Wahllokalen könnten entfallen, wenn elektronische Wahlverfahren auch online, z. B. auf einer offiziellen Website angeboten würde?
- Welche Kostensenkungen würden sich dadurch ergeben?
- Wie hoch wäre der zusätzliche Aufwand, der bei der Einführung von elektronische Wahlverfahren entsteht? Man denke hier beispielsweise an die Beschaffung und Wartung der Wahlmaschinen oder die Information und Unterstützung der Wähler bei der (insbesondere ersten) Nutzung. Oder man denke an Abstimmungen von Gremien [AKV05] (z.B. Aufsichtsräte) oder in verteilten Projekten, bei denen Abstimmungen häufig mit einem hohen Kosten- und Personalaufwand verbunden sind.

2.2.2 Benutzbarkeit

Ein weiterer Aspekt, der die Akzeptanz in der Praxis nachhaltig beeinflusst, ist die Benutzbarkeit (Usability) der Wahlmaschinen bzw. der Websites für Online-Wahlen. Auch hier ergeben sich wieder zahlreiche Fragestellungen, z.B.:

- Wie sollte die Benutzungsoberfläche einer Wahlmaschine bzw. einer Website für Online-Wahlen konzipiert sein?
- Wie kann man den Wähler über das neue Verfahren informieren? Wie sollte eine Anleitung für elektronische Wahlverfahren aussehen, die alle notwendigen Informationen enthält, aber gleichzeitig den Leser nicht mit zuviel Details überfordert?
- Wie kann man die Bürger während einer Online-Wahl unterstützen – ohne dass dabei die allgemeinen Wahlprinzipien verletzt werden?

- Gibt es einen Widerspruch (und daher die Notwendigkeit zur Abwägung) zwischen sicheren und gut bedienbaren Verfahren?
- Beeinflusst der Wechsel vom herkömmlichen Verfahren zum elektronischen Wählen das Ergebnis? So ist zu überprüfen, ob bestimmte Wählergruppen mehr Probleme mit der Bedienung haben als andere und daher mehr Fehler machen oder der Wahl ganz fern bleiben. Ebenso muss untersucht werden, ob durch den Wechsel zu elektronischen Wahlen andere Wählergruppen als bisher dazu motiviert werden an der Wahl teilzunehmen.

Zur Absicherung gegen Manipulationen werden einige technische Maßnahmen vorgeschlagen, die als negativer Seiteneffekt beim Wähler zu praktischen Problemen bei der Benutzbarkeit führen können:

- So wird beispielsweise diskutiert, wie sichergestellt werden kann, dass der Wähler bei einer Online-Wahl auf seinem eigenen PC eine „saubere“ Softwareinstallation ohne Trojaner oder ähnliches vorfindet (siehe auch Abschnitt 1.2.2). Dies könnte durch die Verteilung einer bootfähigen CD erreicht werden. Die Nutzung einer solchen CD kann aber durchaus zu praktischen Problemen führen. Was passiert, wenn das System so konfiguriert ist, dass der PC nicht von CD bootet? Oder die Hardware-Anforderungen des bootenden Systems vom PC nicht erfüllt werden?
- Insbesondere die Benutzbarkeit von Mechanismen zur Identifikation und Authentisierung der Wähler ist ein wichtiger Punkt. Man denke z.B. an die komplexe Handhabung von PKI-Lösungen oder Smartcards durch ungeübte Benutzer oder das „Freirubbeln” von verdeckten Passwörtern auf vorher per Post verschickten Wahleinladungen, wobei die Gefahr besteht, dass der Benutzer aus Versehen Teile des Passwortes nicht richtig freilegt oder unleserlich macht.

3 Politikwissenschaftliche Fragestellungen

Wesentlich beim Konzept der Demokratie ist eine kollektive Entscheidungsfindung durch alle wahlberechtigten Bürger eines Staates. Sie hat sich in den vergangenen zwei Jahrhunderten als Staatsform in mehr und mehr Staaten rund um den Globus durchgesetzt [UNDP02]. Dies kann jedoch nicht darüber hinwegtäuschen, dass sich die Demokratie in Bezug auf die Bürgerbeteiligung am politischen Prozess in einer Krise befindet, wie dies eine Studie des IDEA Instituts zeigt. Mit Ausnahme eines kurzen Aufflackerns während der Zeit des Falls des Eisernen Vorhangs ist die Wahlbeteiligung über die Jahre kontinuierlich gesunken [IDEA02]. Diesem Trend versucht man mit verschiedenen Initiativen entgegenzuwirken, insbesondere durch die Verwendung neuer Technologien, die durch Einführung von Distanzkanälen die Zugänglichkeit der Entscheidungsprozesse erhöhen könnten [IDEA06].

Das Konzept der Demokratie sieht seit Anbeginn die Verwendung von Technologie in Form von unterschiedlichsten Werkzeugen vor. War es zu Zeiten des alten Athens der Einsatz von Tonscherben, so ist die Informationstechnologie das moderne Werkzeug. Die Frage stellt sich nun, in welcher Form Informationstechnologie als Werkzeug im Wahlprozess zum Einsatz kommen könnte. Hier spielt auch das Problem der digitalen Spaltung mit, das von einer unterschiedlichen Verteilung der IT-Nutzung ausgeht. Das heißt, dass Eliten eher in der Lage sind IT zu verwenden als der durchschnittliche Bürger.

Dies führt zu Diskussionen, ob elektronische Wahlen jemals die Papierwahl in Gänze ersetzen können. Im Bereich der Wahl unter Aufsicht einer Wahlkommission ist diese Entscheidung durch die Wahlgeräteverordnung bereits positiv durch die Politik beantwortet worden. Bei elektronischen Distanzwahlen, also Wahlen die am Ort nach Präferenz des Bürgers durchgeführt werden (ähnlich der Briefwahl), ist der Stand der Diskussion derzeit, dass es nur ein zusätzliches Angebot darstellen oder zumindest auf Anfrage eine papier-basierte Stimmabgabe möglich sein soll.

Weiter ist auch fraglich, ob der Einsatz von Informationstechnologie im Wahlprozess einen Einfluss auf das Ergebnis haben könnte. Diese Frage ist insbesondere relevant, weil dadurch entsprechende Wahloptionen bevorzugt werden könnten. Befürworter von elektronischen Wahlen betonen immer die Neutralität ihrer Systeme für das Wahlergebnis.

Bis dies nachgewiesen ist, ist weiterhin fraglich, ob die Entwicklung hin zu Online-Wahlen von Politikern unterstützt werden wird. Das Mittelsmann-Paradoxon geht davon aus, dass gewählte Politiker das System nicht verändern wollen, durch das sie gewählt wurden [MaKr05].

Diese Annahme würde auch erklären, warum sich neue Formen wie komplexe Entscheidungsalgorithmen (z.B. Präferenzwahlen), Kumulieren und Panaschieren, Wählen von Koalitionen oder gar die Durchführung von transnationalen Wahlen oder länderübergreifenden, deliberativen Meinungsumfragen [Fish06] so schwer tun. Alles in allem ergeben sich daraus folgende Fragen:

- Demokratie ist in der Krise durch absinkende Wahlbeteiligung und generell in politischen Prozessen. Wie kann dieser Trend aufgehalten werden?
- Welche Möglichkeiten gibt es, durch IT Wahlen zu unterstützen?
- Kann IT auch neue Formen von demokratischen Entscheidungen unterstützen wie elektronische demokratische Parteien, oder komplexere Entscheidungsalgorithmen, Kumulieren und Panaschieren, Wählen von Koalitionen, oder transnationale Wahlen oder länderübergreifende deliberative Meinungsumfragen ermöglichen?
- Hat der Einsatz von IT Auswirkungen auf Wahlergebnisse? Wenn ja, welche?
- Wie kann die digitale Spaltung verhindert oder abgebaut werden?
- Wollen Politiker den Einsatz von IT in den politischen Prozessen überhaupt oder verhindern sie deren Einsatz?

Fazit

Die genannten Punkte zeigen nur einen Ausschnitt aus der Diskussion, verdeutlichen aber, dass die Online-Wahl keine Eins-zu-eins-Abbildung traditioneller Verfahren sein kann, sondern dass die Papierwahl und die Online-Wahl jeweils ihre Vor- und Nachteile haben. Für den weiteren und verbreiteten Einsatz von Online-Wahlen sind im Wesentlichen die folgenden Fragestellungen zu klären:

- Sollen Gesetze und Verordnungen zu Gunsten einer höheren Sicherheit angepasst werden? Beispielsweise eine Erweiterung der Bundeswahlgeräteverordnung um die Anforderung, dass die Wahlmaschinen auch außerhalb der Wahlperiode sicher aufbewahrt werden müssen.
- Soll neue Funktionalität, die durch die Technik ermöglicht wird, mit in die Systeme und damit in die Regularien integriert werden? Als Beispiele wären hier

die automatische Warnung bei der ungültigen Stimmabgabe oder die Verfolgung der eigenen Stimme durch „Voter Verifiability“ zu nennen.

Darüber hinaus ist es wesentlich, dass die Gesellschaft mit in den Entwicklungsprozess integriert wird, beispielsweise bei der Definition von Anwenderprofilen und in Partizipationsforen.

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Article V

Alkassar, Ammar, **Robert Krimmer** and Melanie Volkamer. 2005. "Online-Wahlen für Gremien: Wahlen in Gremien als Einsatzgebiet für Wahlen ohne vertrauenswürdige Instanz." *Datenschutz und Datensicherheit* 29(8), 480-483. (1.2)

The German discussion of the use of electronic means for casting a vote started with a proposal from Werner von Siemens in the nineteenth century. One hundred years later, the German Bundestag allowed for e-voting machines in the polling station. Every proposal for the polling station, however, required a trustworthy body, such as an election commission, to operate the system. In this paper, the authors present a remote electronic voting protocol that does not demand a central administration body. Additionally, the authors describe how academic departments could use this protocol for decision making in their bodies.

DuD
Datenschutz und Datensicherheit

Online-Wahlen für Gremien

Wahlen in Gremien als Einsatzgebiet für Wahlen ohne vertrauenswürdige Instanz

Ammar Alkassar, Robert Krimmer, Melanie Volkamer

Anspruchsvolle Wahlprotokolle, die ohne vertrauenswürdige Wahlzentrale auskommen, galten lange Zeit als nicht praxistauglich.[1] Im vorliegenden Beitrag stellen die Autoren das Projekt „E-Voting for Academics" vor, mit dem sie zeigen möchten, dass diese komplexen Systeme in bestimmten Anwendungsfeldern umsetzbar sind.

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Einleitung

Elektronische Wahlen sind heute in vielen Bereichen mehr denn je in der Diskussion. Neben der erhofften höheren Partizipation, ist vor allem die Erleichterung der Wahlorganisation ein wichtiges Argument, welches auch im 19. Jahrhundert zur Anwendung des ersten elektronischen Wahlapparates in Deutschland führte. Werner von Siemens stellte 1860 mit seinem Abstimmungstelegraphen das automatische Abstimmungssystem für das preußische Abgeordnetenhaus vor [Siem1891]. Etwas mehr als 100 Jahre später ist in Deutschland seit 1975 die Durchführung elektronischer Urnenwahlen bei Bundestagswahlen, mit der Hilfe nichtvernetzter elektronischer Wahlgeräte in Wahllokalen, durch die Bundeswahlgeräteverordnung [BWahlG] geregelt.

Wesentlich komplexer als der Einsatz von Wahlmaschinen im Wahllokal stellt sich die elektronische Variante der Briefwahl, die Online-Wahl dar, d.h. die elektronische Wahl, die über öffentliche Netze durchgeführt wird. Sichere Online-Wahlen wurden erst durch neue kryptographische Verfahren wie beispielsweise die blinden Signaturen [Chau85] oder die Idee der MIXE [Chau81] Anfang der 80er Jahre möglich.

Die breite Öffentlichkeit interessiert sich seit dem Einzug des Internet in die Büros und die Verwaltungen Ende der neunziger Jahre zunehmend für das Thema Online-Wahlen, für die damit erstmals auch die technische Infrastruktur bereitstand. Der anfängliche Enthusiasmus führte dazu, dass weltweit zahlreiche Projekte ins Leben gerufen wurden, deren Ziel es war, zu zeigen, dass Online-Wahlen auch für den Praxiseinsatz geeignet sind. Dabei kamen bei den entwickelten Systemen eine Vielzahl der in den Jahren zuvor veröffentlichten kryptographischen Protokolle und Konzepte zum Einsatz [Ullm01].

Deutschland erreichte dabei mit Projekten wie i-vote der Forschungsgruppe Internetwahlen [i-vote], dem Projekt „Elektronische Stimmabgabe im Internet" [ESI] und der Wahl zum Jugendgemeinderat Fellbach [Fell01] eine besondere Vorreiterrolle. Dabei kamen sowohl Online-Wahlsysteme zum Einsatz, die als festinstallierte Kiosksysteme im Wahllokal oder als Remote-Systeme von beliebigen internetfähigen Rechnern betrieben wurden.

Nach dem ersten großen Boom der Online-Wahlen und den eher ernüchternden Ergebnissen, verlor das Thema in Deutschland insbesondere in der Politik an Interesse.

Im Gegensatz zu Deutschland setzen eine Reihe von europäischen Ländern Online-Wahlen bereits auf politischer Ebene rechtsverbindlich ein, wie beispielsweise die Schweiz [Brau03] und England [Prat04] oder Estland (für die nächsten Wahlen geplant, [Maat04]).

In Deutschland orientiert man sich zunehmend an dem Konzept des stufenweisen Erfahrungsaufbaus [Karg03] und konzentriert sich auf den nicht-parlamentarischen Bereich. Insbesondere der Bereich von Vereinswahlen erscheint dabei attraktiv. So hat beispielsweise die D21 ihre Vorstandswahl 2003 [D21-2002] und die Gesellschaft für Informatik 2004 ihre Präsidiumswahlen mit 20.395 Wahlberechtigten erfolgreich online durchgeführt. Die GI plant auch in diesem Jahr die Vorstands- sowie die Präsidiumswahlen in Form einer Kombination aus Brief- und Onlinewahl anzubieten [GI-WAHL]. Die Vereine Digitale Brücken e.V. und Digital Bridges e.V. führten 2004 ihre Vorstandsbeschlüsse zur Fusion der beiden Vereine und der diesbezüglichen Details in einem Pilotprojekt über handelsübliche Handys durch [Maus04].

[1] Eine Übersicht der verschiedenen Realisierungsansätze findet sich in [Ullm01].

Neben Vereinswahlen gibt es einen interessanten Einsatzbereich, der bisher aber weitestgehend unberücksichtigt blieb: der Einsatz von Wahl- und Abstimmungssystemen innerhalb von Gremien und Vorständen. Genau an dieser Stelle setzt das Projekt „E-Voting for Academics“ an, das wir in diesem Beitrag vorstellen.

1 Motivation

Ein interessantes Anwendungsfeld sind Wahlen und Abstimmungen im universitären Umfeld. Dabei sind sowohl die Wahlen zu den studentischen Selbstverwaltungsorganen wie dem Studierendenparlament als auch Wahlen zu und vor allem in den universitären Gremien wie dem Senat oder den Fakultätsräten als Evaluationsfeld für Online-Wahlen von besonderem Interesse.

So können in der studentischen Selbstverwaltung die maßgeblichen Ordnungen mit relativ geringem Aufwand angepasst werden. Generell zeichnen sich viele Wahlen und Abstimmungen im universitären Umfeld oftmals durch komplexe Wahlverfahren mit einem hohen personellen Aufwand in der Durchführung aus.

Vereinfacht wird der Einsatz von Online-Wahlen in diesem Umfeld durch die gut ausgebaute Netzinfrastruktur. Erleichtert wird der Einsatz von Internetwahlen darüber hinaus durch die allgemeine Verfügbarkeit vernetzter Rechner bei allen Beteiligten. Dies ermöglicht den Einsatz von weitaus komplexeren Wahlprotokollen.

Die Einführung von Internetabstimmungen/-wahlen bei Universitätsgremien hat auch einen funktionalen Mehrwert: Viele der Entscheidungen, die oftmals in der Eilkompetenz des Vorsitzenden getroffen werden, können mit einem solchen System ohne große Vorlaufzeit für die Gremiensitzungen regulär getroffen werden. Dies ist aus der Sicht der universitären Selbstverwaltungsorgane ein signifikanter Vorteil, da Eilentscheidungen durchaus problematisch sein können.

Weitere interessante Anwendungsfelder ergeben sich beispielsweise bei Abstimmungen innerhalb von Unternehmens-, Partei- und Vereins-Vorständen. Insbesondere bei überregionalen organisierten Verbänden und Unternehmen können Online-Abstimmungen Entscheidungsprozesse erheblich vereinfachen.

2 Wahlprotokolle ohne vertrauenswürdige Instanz

Seit Anfang der 80er Jahre wurden zahlreiche Wahlprotokolle veröffentlicht und teilweise in Wahlsystemen umgesetzt (einen guten Überblick über die unterschiedlichen Protokolle bietet [SMITH05]). Einige der publizierten Wahlprotokolle (z.B. [BeYu86] und [DM83]) wurden in der Vergangenheit aber für den praktischen Einsatz kaum beachtet, obwohl sie über interessante Sicherheitseigenschaften verfügen.

> Diese Protokolle arbeiten ohne zentrale Wahlserver und ermöglichen damit ein weit sichereres Vertrauensmodell. Protokolle, die mit einem oder mehreren zentralen Wahlservern arbeiten, haben den Nachteil, dass die Wähler diesen Servern nahezu uneingeschränkt vertrauen müssen. Die gezielte Manipulation eines dieser Server kann ausreichen, das Wahlergebnis unbemerkt zu verändern.

Wahlprotokolle ohne zentrale Wahlserver verwenden meist Secret Sharing Verfahren oder beruhen auf dem Prinzip des zufälligen Verwürfelns bzw. Vermischens der Stimmen, wobei die Wahlsoftware als eine Art MIX [CHAU81] fungiert. Die Protokolle sind derart gestaltet, dass (a) jede Wählerin/jede Wählersoftware das Ergebnis selbst berechnet und somit keiner zentralen Stelle vertrauen muss, (b) diese das Ergebnis korrekt berechnet und (c) korrekt veröffentlicht. Außerdem kann jeder Wähler bei diesen Protokollen selbstständig sicherstellen, dass sein Stimmgeheimnis gewahrt bleibt, unabhängig von dem Verhalten eines oder mehrere Server und unabhängig vom Verhalten der anderen Wähler beim Protokolldurchlauf.

Der Nachteil dieser Protokolle liegt im Nachrichtenaufkommen, welches mit der Anzahl der Wähler quadratisch zunimmt. Diese Ineffizienz bei großen Wählergruppen führte dazu, dass diese Protokolle für den praktischen Einsatz nie ernsthaft in Betracht gezogen wurden.

Im Projekt „E-Voting for Academics“ zeigen wir, dass Wahlprotokolle ohne zentrale Wahlserver für kleine Wählergruppen durchaus sinnvoll einsetzbar sind und realisieren ein entsprechendes System. Die Software „eVote“ ist ein Wahlsystem für Universitätsgremien, wie Forschungsausschuss, Fakultätsräte oder den Senat. Diese Gremien haben üblicherweise eine überschaubare Anzahl an Mitgliedern (meist zwischen 10 und 30), die an eine Infrastruktur wie etwa das Universitätsnetz angeschlossen sind, die das hohe Nachrichtenaufkommen vertretbar macht.

3 *eVote* Systembeschreibung

Das in *eVote* umgesetzte Protokoll ist eine Erweiterung des bereits in [DM83] veröffentlichten Ansatzes von Michael Merritt und beruht auf dem Prinzip des Mischens der Stimmen. Jeder Wähler erhält nach seiner eigenen Stimmabgabe nacheinander zweimal alle Stimmen in verschlüsselter Form und durchmischt diese zufällig. Nach Protokollabschluss verfügt jeder Wähler über alle Stimmen im Klartext und kann das Ergebnis selbst berechnen.

3.1 Voraussetzungen

Dabei wird vorausgesetzt, dass jeder Wähler über ein eigenes Schlüsselpaar verfügt und die integeren öffentlichen Schlüssel der anderen Gremienmitglieder kennt. Dies ist bei kleinen Wählergruppen aber keine Hürde, da eine PKI in dem Sinne nicht erforderlich ist. Der mit *eVote* erzeugte Schlüssel kann problemlos offline ausgetauscht werden.

Angenommen wird außerdem – wie bei allen anderen Wahlsystemen auch – dass die zur Wahl eingesetzten Rechner sicher sind, also insbesondere keine Malware die abgegebene Stimme vor dem Verschicken verändert und auch keine Information über den Inhalt einer Stimme verbreiten kann.

Wir gehen von einem aktiven Angreifer aus, der das Netzwerk vollständig kontrolliert, der aber kryptographisch beschränkt ist. Zu den Angreiferzielen zählen die Offenlegung des Stimmgeheimnisses sowie die Manipulation des Wahlergebnisses.

3.2 Protokoll

Insgesamt umfasst das Protokoll fünf Runden, die im Folgenden erläutert werden:

- **Verschicken der Wahlberechtigung:** Der Vorsitzende und damit Initiator W_i der Wahl verschickt die Wahlbenachrichtigung an alle n Wähler, Die Wahlbenachrichtigung enthält neben den eigentlichen Stimmzettel auch die Wählerliste, wobei die Reihenfolge der Wähler in

dieser Liste (W_1, W_2, ..., W_n) eine entscheidende Rolle für das weitere Protokoll spielt.

- **Generierrunde:** Die Generierrunde beginnt mit der Stimmabgabe des einzelnen Wählers. Die Stimme wird mehrfach verschlüsselt und an Wähler W_1 zur Weiterverarbeitung verschickt. Im Einzelnen wird die Stimme nacheinander zweimal mit dem öffentlichen Schlüssel jedes Wählers aus der Wählerliste verschlüsselt, beginnend mit dem öffentlichen Schlüssel von W_n. Dabei wird nur für die äußeren Verschlüsselungen ein semantisch sicherer Verschlüsselungsalgorithmus eingesetzt und für die innere ein deterministisches Verfahren, da für spätere Überprüfungen die einzelnen Zwischenschritte nachvollzogen werden müssen.
- **Vertauschen-Runde:** In dieser für die Geheimhaltung der Wählerstimme entscheidenden Runde erhält jeder Wähler W_i in der entsprechenden Reihenfolge alle verschlüsselten Stimmen und geht folgendermaßen vor: Zunächst überprüft er anhand der gespeicherten Zwischenergebnisse, ob seine eigene Stimme in der Liste enthalten ist, dann entfernt er eine Verschlüsselung, durchmischt die immer noch verschlüsselten Stimmen zufällig und schickt den so entstandenen Datensatz an seinen Nachfolger W_{i+1} weiter. Am Ende der Runde erhält jeder von Wähler W_n eine Liste von Stimmen, die jetzt nur noch einmal mit jedem Wähler-Schlüssel verschlüsselt sind. Jeder Wähler überprüft, ob seine Stimme dabei ist und schickt ggf. eine Bestätigungsnachricht an den Wähler W_1.
- **Konsistenzprüfung:** Mit dem Erhalt aller Bestätigungsnachrichten beginnt W_1 die nächste Runde. Nacheinander erhält wieder jeder die Liste mit den verschlüsselten Stimmen, um eine Verschlüsselungschicht zu entfernen. Dies wird solange fortgesetzt bis die Stimmen beim Wähler W_n im Klartext vorliegen. Im Unterschied zur vorherigen Runde werden die Stimmen nicht durchmischt und die Liste wird nicht nur an den Nachfolger, sondern an alle Wähler geschickt. Außerdem entfernt der Wähler die entsprechende Verschlüsselungsschicht erst dann, wenn alle Wähler bestätigt haben, dass die erhaltene Liste konsistent zur vorherigen ist und damit alle Stimmen enthalten sind.
- **Auszählen:** Nachdem W_n alle Stimmen im Klartext hat, schickt er sie an alle Wähler, die nach einem Konsistenzcheck zur vorherigen Runde die Stimmen auszählen.

Eine detaillierte Beschreibung des Protokolls ist in [eVote] zu finden. Hier steht auch der Prototyp zum Download bereit. Im Gegensatz zu anderen verfügbaren Wahlsystemen kann jedes Gremium *eVote* ohne die Hilfe eines Providers kostenlos einsetzen, da der Initiator der Wahl das Wählerverzeichnis sowie den Inhalt des Stimmzettels selbstständig generieren kann. Das System kann auch eingesetzt werden, um mehrere Wahlen parallel durchzuführen.

4 Sicherheitsanalyse

Anforderungen an Wahlen in Deutschland werden im Wesentlichen von den fünf Wahlrechtsgrundsätzen (freie, allgemeine, geheime, unmittelbare, gleiche Wahl) abgeleitet. Diese sind im Grundgesetz verankert. Die *unmittelbare* Wahl fordert, dass keine Wahlmittelmänner gewählt werden, die dann über das eigentliche Wahlergebnis abstimmen. Aus diesem Wahlrechtsgrundsatz lassen sich keine spezifischen Anforderungen an ein Online-Wahlsystem ableiten und er wird daher bei der folgenden Analyse nicht weiterbetrachtet.

Der Wahlrechtsgrundsatz der *freien* Wahl verlangt, dass der Wähler seine Stimme ohne Zwang und Druck sowie ohne Beeinflussung abgeben kann. Bei remote Online-Wahlen ergibt sich hier also eine Verschiebung. Während bisher im Wahllokal die Wahlhelfer und in der Versammlung der Vorsitzende sicherstellen musste, dass die Wähler ihre Stimme unbeeinflusst abgeben können, ist der Wähler, der seine Stimme im privaten Umfeld abgibt, selber dafür verantwortlich, dass er seine Stimme unbeeinflusst abgibt. Damit ergeben sich auch aus diesem Wahlrechtsgrundsatz keine spezifischen Anforderungen an ein Online-Wahlsystem als solches, sondern es muss auf einer anderen Ebene diskutiert werden, ob es vertretbar ist, die Verantwortung für die freie Stimmabgabe in die Hände des Wählers zu legen.

Die Anforderungen, die sich aus den anderen drei Wahlrechtsgrundsätzen ergeben, werden von *eVote* erfüllt. Im Gegensatz zu anderen Wahlsystemen können sich die Wähler sogar selber davon überzeugen und brauchen keiner Instanz/ keinem Server diesbezüglich zu vertrauen.

Der Wahlrechtsgrundsatz der *allgemeinen* Wahl verlangt, dass alle Wahlberechtigten die Möglichkeit haben an der Wahl teilzunehmen und der Grundsatz der *gleichen* Wahl, dass alle Wähler hierzu die gleiche Möglichkeit haben, d.h. alle Wähler genau einmal ihr Stimmrecht ausführen können und jede abgegebene Stimme genau einmal gezählt wird mit dem Inhalt, für den sich der Wähler entschieden hat. Diese beiden Wahlrechtsgrundsätze werden von *eVote* gewährleistet, da jeder Wähler anhand der Wahlnachricht/dem Stimmzettel überprüfen kann, ob alle Mitglieder des Gremiums gelistet sind. Außerdem kann am Ende nur dann ein Ergebnis ermittelt werden, wenn von jedem Wähler/Gremienmitglied eine Stimme abgegeben wurde. Es ist also nicht möglich, unbemerkt Stimmen zu entfernen. Auch das Austauschen von Stimmen fällt bei der Konsistenzprüfung in der zweiten Runde auf, so dass auch hier die gleiche und allgemeine Wahl nicht verletzt wird.

An einer Stelle setzt *eVote* den Wahlrechtsgrundsatz der allgemeinen Wahl sehr stark um, vermutlich für einige Wahlverfahren zu strikt. Das Wahlprotokoll durchläuft nur dann alle Runden, wenn auch alle Wahlberechtigten ihre Stimme abgegeben haben. Dies bedeutet, dass eine Art Wahlpflicht vorausgesetzt wird. Angriffe auf die Verfügbarkeit (beispielsweise durch Denial of Service Angriffe) und damit indirekt auf die allgemeine Wahl werden nicht betrachtet, da dies wie bei jeder Internetanwendung ein noch zu lösendes Problem ist.

Der Wahlrechtsgrundsatz der *geheimen* Wahl fordert zum Einen, dass es keinen Zusammenhang zwischen Wähler und seiner Stimme geben darf, und zum Anderen, dass das Wahlsystem ihm keine Möglichkeit geben darf, zu beweisen, für welche Kandidaten er sich entschieden hat oder allgemein welche Auswahl er getroffen hat. Auf diese Weise wird der Stimmenkauf unterbunden. Dieser Grundsatz wird durch eine Art MIX-Verfahren sichergestellt: Die bei einem Wähler/einer Wahlsoftware ein- und ausgehenden verschlüsselten Stimmzettel können durch die Entfernung einer Verschlüsselungsschicht, das zufällige Durchmischen und die Tatsache, dass die Verschlüsselung der äußeren Schicht semantisch sicher ist, einander nicht mehr zugeordnet werden. Damit kann der Wähler selbst die geheime Wahl sicherstellen –

unabhängig davon, ob die anderen Wähler die Stimmen ordnungsgemäß durchmischen oder nicht.

Das Entfernen einzelner Stimmen zwecks Brechen der geheimen Wahl ist in der ersten Runde sicherheitskritisch: Hier sieht der Angreifer, wessen Stimme er entfernt hat, da der entsprechende Wähler das Protokoll spätestens im letzten Schritt der ersten Runde abbricht. Dies bedeutet insbesondere, dass der entnommene Datensatz nicht im Klartext vorliegt und der Angreifer damit nicht den Inhalt der Stimme erfährt. Ein Entfernen einer Stimme im Verlauf der letzen Runde führt zwar auch zum Protokollabbruch, aber hier brechen alle Wähler das Protokoll ab, so dass der Angreifer den abgegriffenen Datensatz keinem Wähler zuordnen kann.

Fazit

Besonders die Wahlen in kleinen Gruppen, wie etwa in akademischen Gremien oder in Vorständen eignen sich für die Einführung von Online-Wahlen. Insbesondere der Notwendigkeit, kurzfristige Entscheidungen zu treffen, kann mittels Online-Wahlen Rechnung getragen werden.

Im Projekt *eVote* haben wir gezeigt, dass in diesen Bereichen theoretisch anspruchsvolle Protokolle eingesetzt werden können, bei denen das Datenaufkommen zwar höher, die Verfahren aber bezüglich des Vertrauensmodells sicherer sind. Hierzu haben wir eine Erweiterung des Merritt-Protokolls [DM83] im Rahmen des Projektes „E-Voting for Academics“ prototypisch implementiert und die Realisierbarkeit demonstriert.

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APPENDIX (Articles VI – X)

Article VI

Prosser, Alexander and **Robert Krimmer**. 2004. "Electronic Voting in Europe." *Proceedings of the 1st ESF TED Workshop on E-Voting*. LNI P-47. Bregenz: GI. (4.2)

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This volume contains papers from the July 2004 ESF-sponsored workshop on Electronic Voting in Europe – Technology, Law, Politics and Society held in Schloß Hofen/Bregenz at the wonderful lake of Constance in Austria. Topics of the contributions cover all aspects (technology, law, politics and society) of Electronic Voting in the European countries.

Alexander Prosser, Robert Krimmer (Eds.): Electronic Voting in Europe

P-47

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Preface

The emergence of the Internet and other electronic-commerce technologies has fundamentally altered the environment in which governments deliver services to citizens, businesses, and other government entities. Many countries have launched electronic government programs to develop a new way of interaction with the government for companies and citizens. Too often those efforts only concentrate on the administrative side neglecting the democratic processes. Still there are ambitious governments and institutions that have taken a step ahead to develop electronic democracy initiatives. Electronic voting, being the most important form of decision making by citizens, is the main driver for such projects and at the same time the biggest obstacle due to the complexity of the topic.

It is therefore important to discuss the concepts and experiences made with electronic voting. One key research program for this is the "Towards Electronic Democracy" project sponsored by the European Science Foundation. The aim of the program is to draw on the modern methods of decision analysis and group decision support, deployed over the WWW, in order to involve the public in decisions.

During the 2003 TED summer school in Varenna the idea came up to organize a specialised workshop to discuss the developments in electronic voting in Europe not only from the perspective of one isolated discipline but in an interdisciplinary approach covering technology, law, politics and society. Together with the conference location in Bregenz at the beautiful Lake of Constance, surrounded by Switzerland, Germany and Austria, it convinced the steering committee to go ahead with the project.

We wish to thank Wolfgang Polasek, Simon French, Fabrizio Ruggeri and the remaining members of the TED steering committee for making this interesting workshop with 20 presentations from 11 European countries possible. It is the largest accumulation of information on electronic voting to date.

Further thanks go to the German Society of Informatics and the Lecture Notes in Informatics editorial board under Prof. Mayr and Jürgen Kuck from Köllen Publishers who made it possible to print the workshop proceedings in such a perfect manner. We are also indebted to the Austrian Computer Society with its forum Electronic Government that has now hosted the working group E-Democracy/E-Voting for the third year. The working group has been a forum for interesting discussions that would not have been possible otherwise.

We gratefully acknowledge the support of Jürgen Weiss, MP as we could always approach him for advice and support with his long year experience in organizing elections.

Finally, we also want to thank our colleagues from the Vienna University of Economics and Business Administration, Department of Production Management, who have supported us since our initial idea to research on the topic of e-Voting.

Vienna, July 2004 Alexander Prosser, Robert Krimmer

Content

Article VII

Krimmer, Robert and Melanie Volkamer. 2005. "Bits or Paper? Comparing Remote Electronic Voting to Postal Voting." In *EGOV 2005*. Schriftenreihe Informatik 15. Linz: Trauner, 225-232. (3.2)

BITS OR PAPER?
COMPARING REMOTE ELECTRONIC VOTING TO POSTAL VOTING

Robert Krimmer[1], Melanie Volkamer[2]

Abstract: In the recent years it has often been discussed how elections can be conducted via the Internet. Many countries, including Germany, Estonia, Great Britain, Switzerland, USA or Austria have run tests of implementing e-Voting on different levels. Whilst offering e-Voting for public elections implies various legal problems, associations can allow for e-Voting in a relatively easy way. In this paper we investigate an election run by the leading German non governmental organization (NGO) in information technology – the Gesellschaft für Informatik (GI) - that provided for remote voting using postal voting and electronic voting via the Internet. It is a common requirement by election officials for remote e-Voting to be as secure as regular postal voting. To come up with an assessment the use of a criteria catalogue is best to compare these forms of voting.

1. Introduction

With the rising use of the Internet and the transformation of paper based transaction processes into electronic enabled online applications it was only a matter of time till the first projects thought of an electronic voting process. So in the recent years many organisations have thought about such an application out of different reasons[3]. One of the reasons has often been to raise the participation rate of the electorate. In many cases the way to do so was introducing remote voting either on paper (postal voting) or electronically (remote e-Voting). Both methods share common problems like family voting but also have contradictory problems like securing the anonymity.

As elections in general are processes developed over time and closely tied to a country's or organisation's history, e-Voting projects vary a lot. As the development of applications for support of the democratic processes is very demanding and costly, international best practices and experiences are searched for intensively. Still due to the nature of democracy applications they are very individual and therefore it is difficult to compare them without taking certain pre-conditions into account.

Whilst in the field of e-government yearly benchmarks are organized by Cap Gemini [2], first comparative studies in the field of e-democracy (i.e. including e-participation and e-Voting research) have been conducted by Macintosh [3], Braun et.al. [4], and Kersting [5]. The most comprehensive study on e-Voting in Europe has been organized by Leenes and Svenson [6].

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3 For an overview of European e-Voting projects see the proceedings of the ESF TED workshop on Electronic Voting in Europe in [1].

All studies found that the context of the e-democracy applications influenced the way of implementation massively.

In an effort to develop a criteria catalogue for comparison of e-Voting projects the approach in [7] is to differentiate between different preconditions that usually influence the way elections are held. They differentiate them in four dimensions, i.e. (1) technology, (2) law, (3) politics and (4) society.

Further more during the introduction of e-Voting legal regulations require remote e-Voting to provide for the same level of security as any other form of remote voting, i.e. postal voting. In order to assess these services for their level of security it is necessary to compare the specific conditions and processes of the remote voting channels based on a criteria catalogue. So we modified the previous mentioned catalogue to fit our purposes of comparing two remote voting channels in a practical experience. Further we chose the election of the Gesellschaft für Informatik (GI)[4]. It is a perfect place to undertake such an investigation as it is a community of technology-fit users but share a critical point of view towards innovations in the information science field.

In this article we first come up with common problems of remote elections and then introduce the criteria catalogue. We continue with the case study of the GI election using the catalogue and finally give an assessment towards the issues of remote elections.

2. Shared Problems and Risks of Remote Voting

As it is shown in [8] postal voting and remote electronic Voting are distance election forms and so there are some common problems concerning the free and secret election principle. This is because casting the vote does not take place in a secure environment like in a polling booth positioned in a polling station but in a private environment. Therefore a local election committee cannot ensure that a voter can cast her vote in secrecy. Similar problems arise in respect to the free election principle due to problems like family voting, electoral enforcement and vote buying. So now it is not the election committee but the voter who has to protect the election principals of a free and secret election.

In [8], the authors compare the new remote electronic voting to the already existing postal voting in regard to a security point of view. With the usage of postal voting, there exist difficulties in respect to the secret, equal and universal election principals. The problem to ensure a secret election arises from the fact that the voting material is sent to the election administration in one envelope. So an attacker could catch the labelled letters on their way from the voter to the election administration and open them. Further problems arise from the mail delivery time whereby the equal and universal election principles may be at risk, but those are common postal delivery problems.

Using a remote e-Voting system, the main problems concern the secret, free and universal election principals and are due to the insecurity of the voter's PC. We can think of several attacks involving Trojan horses: One would be that the Trojan horse would send the cast ballot unencrypted from the voter's PC to the attacker (violation against the secret election

[4] The Gesellschaft für Informatik (GI) was set up in 1969 in Bonn as a registered association. Its intention is to promote the computer science. The GI's electoral laws are bound in the articles of association (see [9]-[11]) and the election reulations (see [12]). For the rest of this paper we will use the short cut.

principal) or the Trojan horse could change the ballot on the voter's PC before it is sent it to the election server (violation against the free election principal). All of this could be done without any further input or notice of the computer user and done completely automatically. And at last the universal election is endangered because of denial of service attacks.

3. Criteria Catalogue

The comparison of e-Voting projects is very difficult as they normally represent very individual developments for the respective organisations or nations as it was shown in the cross-national studies [3 – 6]. This criteria catalogue is a modified version of the second part from the one available in [7], especially refined to compare a traditional paper based remote voting channel to a remote e-Voting channel. It consists of three parts: (1) a **project overview**, (2) the **technology** used, and (3) the **outcome of the project**. So our main focus it the technology because law, politics and society are the same for both types of elections.

In the following we will use this criteria catalogue to assess the use of postal and remote electronic voting in the GI election 2004.

1	**Project Overview**	2.2	Procedural Issues
1.1	General Project Description	*2.2.1*	*Postal Voting Procedure*
1.1.1	*Form of Voting Used*	*2.2.1.1*	*Election Principles (Free, Equal)*
1.1.2	*Status*	*2.2.1.2*	*Kind of Identification*
1.1.3	*Duration*	*2.2.1.3*	*How to Guarantee Anonymity*
1.1.4	*Sustainability*	*2.2.1.4*	*Double Voting Protection*
1.1.5	*Location of Tests (Public/Private)*	*2.2.1.5*	*Protection against Ineligible Voters*
1.1.6	*Aim*	*2.2.1.6*	*Protection against Counting of Votes before End of Election*
1.2	Resources	*2.2.1.7*	*Identification of Fraud*
1.2.1	*Budget (amount, funds)*	*2.2.1.8*	*Possibility of Checks and Balances by Election Committee*
1.2.2	*Actors*	*2.2.2*	*Remote eVoting*
1.2.2.1	*Whose initiative*	*2.2.2.1*	*Election Principles (Free, Equal)*
1.2.2.2	*Level of Governmental/Organizational Support*	*2.2.2.2*	*Kind of Identification*
1.2.2.3	*Positions of Actors*	*2.2.2.3*	*How to Guarantee Anonymity*
1.2.3.4	*Scientific Background*	*2.2.2.4*	*Double Voting Protection*
1.3	Scope	*2.2.2.5*	*Protection against Ineligible Voters*
1.3.1	*Legal Validity*	*2.2.2.6*	*Protection against Counting of Votes before End of Election*
1.3.2	*Participants and Turnout*	*2.2.2.7*	*Identification of Fraud*
1.4	Promotion	*2.2.2.8*	*Possibility of Checks and Balances by Election Committee*
2	**Technology**	2.3	Security of Remote eVoting
2.1	General	*2.3.1*	*Examination and Certification of System*
2.1.1	*Postal Voting*	*2.3.2*	*System Stability and Load Balancing*
2.1.1.1	*Process of Postal Voting*	*2.3.3*	*Organisational Surveillance of System*
2.1.1.2	*Failure Rates of Mail Delivery*	*2.3.4*	*Crisis Management Guidelines*
2.1.1.3	*Quality of Mail Addresses*	*2.3.5*	*Defense against DOS Attacks*
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2.1.2.1	*Hard- and Software Used*	*2.3.7*	*Protection against Spoofing, Man-in-the-middle-Attack, Security*
2.1.2.2	*Developer and/or Provider*	*2.3.8*	*Organizational Measures against Access to the Servers*
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		3	**Outcomes**
		3.1	Results of Evaluation
		3.2	Other Outcomes
		3.3	Critical Success Factors
		3.4	Contentedness of the Voters

Table 1: Criteria catalogue to compare e-Voting with postal voting within a concrete example

4. The Case Study

In Germany in the current past, three associations applied an e-Voting system for legal binding elections[5]. The most popular one and the one with the largest amount of voters, in December 2004, was the GI's chairman election. They used the remote e-Voting and postal voting and so it is a very good example for our case study. In the following we will apply the criteria catalogue to compare the security of postal voting with the one of remote e-Voting[6].

4.1 General Project Overview

4.1.1 General Description

The voters had the possibility either to use remote e-Voting form their own PCs or they could use postal voting (*type of project*). The election was a pilot project[7], but never the less it was legal binding (see election information letter) (s*tatus of the project*). Since the GI articles for voting have been changed it is possible to use e-Voting for all GI elections. The main process to offer e-Voting as an additional voting channel in an election started in 2003. The management board presented their request to the chairmen in January of 2004 and the chairmen agreed. In autumn 2004 the chairmanship decided to use Micromata's POLYAS system for the next chairman election. Finally the POLYAS system was in operation from the 15th of October to the 10th of December 2004 12.00 noon (*duration of the project*). Before the election, the election committee explained that it is a pilot project and only its success will decide on its future use. The election succeeded according to all participants and so it is planned to use it again for the election in December 2005 (s*ustainability*).

Before this legally binding election there was a test election (the 30th of September and the 6th of October). 99 chosen GI members had the possibility to vote under the same conditions in order to test the system. These members had the possibility to return feedback. The great amount of suggestions of improvement had been realized and after that 10 of the 99 GI members had again the possibility to test the improved system (*location of tests*). There were many factors why the GI decided to apply e-Voting in their elections. First they write that they want to try new technologies and innovative methods. Another aim was to dispel the security doubts against electronic voting systems and the GI hoped to increase the voter turnout. Another reason to apply e-voting was the quick election results and the fact that the GI can become a precursor for other associations (*aim of project*).

4.1.2 Resources and Actors:

In this part not many detail information is public available. The GI did not make any numbers on *budget* or *source of funding* available to the public. The same holds for *initiative*, the *actors/levels of government* and *number of agencies involved* as well as for *scientifical support and evaluation, pro and contra of actor* and *promotion*.

In the chairman election there were 20.395 eligible voters. 4.845 members cast their votes electronically and 81 persons used postal voting. So the voter turnout has been 24,2% what

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[5] The associations are the GI, the D21 [13] and the Digitale Brücke [14].

[6] We used only material provided to the public either by web research or by reference from the GI or Micromata, which can be found in the references [15] – [22].

[7] Pilot project meant that only if it works, e-Voting will become a standard solution for the future and if not, e-Voting would be dropped in favour of solely a postal voting solution

means that in comparison to the last chairman election in 2003 56% more GI members participated the election in 2003 (*participation and voter turnout*).

4.2 Technology

4.2.1 Postal Voting

Every GI member got a letter with the election information, briefings to use the e-Voting system, and the covered TAN code on the front. On the reverse side there was the information necessary to request postal voting material. An additional paper informed the voter about the usage of e-Voting in the GI. So if a voter preferred postal voting she had to fill out the form on the reverse side and send it back to the GI office (the postage was paid by the GI). In the next step the GI sent this voter the postal election records - a ballot, two special envelops, information about the candidates, and an additional paper for the voter's signature [12], then the user could cast her candidates and sent it back to the GI office. (*process of postal voting*).

In Germany the mail delay for letters is very short especially for national mails: 95 % letters needs only one day and after two days 99% of all letters are delivered (*Failure rates of mail delivery*). Even Europe-wide 97,1 % of the letters are delivered within 3 days.

The voter's *identification* attribute within the postal voting is the voter's personal signature - as usually with postal voting in Germany. To ensure a *secret*/anonymous election, the GI election letters consists as usual out of two different envelops: the main one which consists of a paper with the voter's personal signature and voter identification attributes on it and a second envelop with the ballot inside. So identity and closed ballot envelop are separated before opening the ballot envelop. To exclude *double voting* the election record is only sent once to every voter, also if the voter complains that she has not received it or in case she cannot find it anymore. In both cases – e-Voting and postal voting – there is no special *protection against ineligible voters*. Many GI members use their office address and so they get the election records there which are not as trustworthy as those at home, because everyone in the company has access to it (Family voting becomes possible).[8]

With respect to the *protection against counting of votes before the end of the election* and the *identification of fraud* the GI *election committee* consists of people with different interests so they control each other. Especially they check if no ballot letter has been opened before the end of the election, because it cannot be closed again so it will be visible if some of the envelopes have already been opened.

4.2.2 e-Voting

The voters can use almost all common browsers to cast their votes without Netscape 4.7.x[9] and Lynx (*Client Software*). The infrastructure for the GI's chairman election was provided and advised by Micromata. The used severs were situated in a secure data processing service center. The whole system is based on open source software like Linux, Apache, Tomcat, Open SSL and Postgrep SQL, so it is possible to use the software in any environment (*hardware and software*).

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[8] Due to the nature of the identification form in the used e-Voting software this is an issue affecting both remote e-Voting and postal voting.

[9] The electoral page was not presented correctly with Netscape 2.7.x but never the less the voter can cast her vote with it.

The e-Voting software POLYAS was developed by the company Micomata Objects GmbH, which has its domicile in Kassel (Germany). The first time POLYAS was used, was in 1996 in Finland. Until now, about 250.000 voters cast their vote with this system (*developer and provider*).

The voter *identification* and authentication is based on a PIN/TAN technique. The voter uses as her PIN her membership number and her TAN is given her on the election records (under a covered field, so that no one else can read and use the TAN unnoticed). The TAN consisted on 12 characters (62^{12} possibilities). The main idea to ensure an *anonymous election* is the usage of pseudonyms. After the registration with a correct PIN/TAN combination, the electoral server allocates the voter to an internal ID which is called 'election token' and is later used to identify the ballot. The token is a random generated character string that is sent back to the voter (but not visible there) and in addition the election server sends it to the second election server the so called box server (but no additional information about the voter's identity). The allocation from the internal ID to the GI membership number on the election server is deleted immediately there and overwritten at the box server after the final ballot casting and cannot be reconstructed anymore. The only information bounded to the GI membership number at the election server is the information that this member has cast her vote electronically and that she is not allowed to cast again a ballot (*double voting protection*). Subsequently no allocation from the voter to her ballot exists, even if the attacker knows both the data from the election server and the box server. So on the one hand side the absolute separation from two servers ensures a secret and anonymous election and on the other hand side the usage of SSL for the communication between the two servers and the servers and the voter's PC. In addition to that Micromata has been committed to the German data protection principles.

With respect to *protection against ineligible* voters the difficulties are the same as with postal voting because the election record with the TAN was sent via. The POLYAS system computes continuously hash codes for the incoming ballots together with the already saved ones, so that it is impossible to manipulate the ballots later on, unnoticed, because then there is a mistake in the logical chain of the computed hash codes. In addition POLYAS provides the possibility to print the ballots in order to count the ballots again (*identification of fraud*).

The election committee is responsible for a correct election process but finally it has to trust Micromata that everything works correctly, but with Micromata and the experts we do not have people with different interests like the people on the election committee so it is not obviously that they control each other.

4.2.3 Security of e-Voting

The GI established a group of security experts to accompany the pilot election and the future process of e-Voting in the GI. This group examined the system, including the source code, the specification, and the documentation. The recommendations were realized by Micromata. The system has been checked in particular with regard to data protection and manipulations. The group consists of German university professors who are national and international known for their expertise in information security and for e-Voting and in addition e-Voting experts from the PTB (Physikalisch-Technische Bundesanstalt, Berlin): Prof. Dr. Brunnstein, Prof. Dr. Grimm, Prof. Dr. Pfitzmann, Prof. Dr. Dieter Richter, PTB Berlin (*examination, certification of the system*).

Micromata uses redundant servers to improve the *system stability.* In addition Micromata performed endurance testing (*load balancing*).

With respect to the *organisational surveillance of system – watchdog* we only know that the server are situated in a secure data processing service centre. There is no information available with respect to a *crisis management* as well as with respect to *defence against DoS attacks, viruses*, and *Trojan Horses* as well as against *Spoofing, Man-in-the-middle-attacks* and *security leaks*.

Access to the election servers is only possible for exclusive persons and in any case it is only possible if at least two persons are present. In addition every access to the server is logged and no other programs can change something according to the election software, databases or ballots because POLYAS is the only software that runs on the servers (*organizational measures against access to the servers*).

4.3.3 Outcomes

There was no special evaluation after the election, but there was a forum on the GI's web pages where people could enter their opinion. Most of the comments are positive ones (*result of evaluation*).

To the points *other outcomes*, *critical success factors*, and *contentedness of the voters* no information is available beside the fact that a speaker of the GI said in an interview that the election was successful and that no manipulation has been noticed.

5. Conclusion

In our analysis we assessed the level of security in remote e-Voting compared to postal voting in a multi-channel election. To compare this we developed a criteria catalogue based on previous comparative surveys in the field of e-Voting. For our assessment we selected the pilot project by the Gesellschaft für Informatik (GI) who conducted a multi-channel election offering solely remote voting channels but both electronically (remote e-Voting) and paper based (postal voting). This speciality made it very interesting to further investigate this project.

On one hand we showed that both channels share common problems in the field of secrecy of the vote in the vote casting stage is concerned. It also showed that the process of integrating multiple channels of voting results in a much higher complexity basically on the back end but not necessarily for the voter. In contrast the end users were very happy with the system which was proven by a much higher participation rate.

Overall the system used by the GI is a simple solution to a typical problem of a registered association and offers valuable information and experiences for other projects in the field of e-Voting. Still it is questionable if such a system as used by the GI would incur more problems in the field of security issues when there would massive interest of hackers in manipulating the election results. For primary elections as an election to the Bundestag one would have to use a much more advanced system – at the current level of e-Voting technology probably a kiosk system - to fully guarantee the legal election principles but one can definitely profit from the experiences made with the GI elections.

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Article VIII

Krimmer, Robert. 2006. "Electronic Voting 2006." *Proceedings of the 2nd Conference on Electronic Voting*. LNI P-86. Bregenz: GI. (4.2)

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Robert Krimmer (Ed.): Electronic Voting 2006

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Lecture Notes in Informatics

Robert Krimmer (Ed.)

Electronic Voting 2006

2nd International Workshop
Co-organized by Council of Europe,
ESF TED, IFIP WG 8.5 and E-Voting.CC

August, 2nd – 4th, 2006
in Castle Hofen, Bregenz, Austria

The 2006 conference on Electronic Voting took place in Castle Hofen near Bregenz at the wonderful Lake Constance from 2nd to 4th of August. This volume contains the twenty papers selected for the presentation at the conference out of more than forty submissions. To assure scientific quality, the selection was based on a strict and anonymous review process. The papers cover the following subjects: e-voting experiences, social, legal, political, democratic and security issues of e-voting, as well as solutions on how to (re)design election workflows, and finally how to implement and observe electronic voting systems.

P-86

Proceedings

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Preface

It is now two years since we last met at Castle Hofen to discuss important topics involved with electronic voting. Back then it was intended to bring together interested people in e-voting. What was first planned as a sole academic meeting in the field of information technology has fast become a get-to-gether of academia, administration and vendors in the field. This is for sure due to the high level of interdisciplinary and high interest on all sides.

Two years ago we listened to the presentation of the Council of Europe recommendation on legal, technical and organisational on electronic voting or many other ambitious plans on implementing electronic voting.

Looking at this year's contributions we can easily see the fast development the field has undertaken. First of all thanks to the support of the Council of Europe our meeting serves as an academic review meeting for the back then discussed recommendation. Second we also have first empirical data on the actual use of e-voting in legally binding political elections and deal with so important topics like the observation of electronic voting. It is also good to see that the discussion on electronic voting is becoming a global one. While in 2004 the attendees of the workshop came from 11 countries, this year we have participants coming from nearly 30 different countries as far away like New Zealand or Brazil.

For our call of papers we received over 40 submissions of which we had to select the 20 best for presentation. This was done in a double-blind review process which wouldn't have been possible without the tremendous effort the programme committee members and the additional reviewers put in the process.

Special thanks go to the Council of Europe for their support in organizing this conference. I wish to thank Simon French, Wolfgang Polasek, David Rios, and Simon French as well as the remaining members of the TED steering committee for supporting once more our workshop.

Further thanks go to the German Society of Informatics and the Lecture Notes in Informatics editorial board under Prof. Mayr and Jürgen Kuck from Köllen Publishers who made it possible to print the workshop proceedings in such a perfect manner. We are also indebted to the Austrian Computer Society, the Federal Computing Centre for their continued support.

Without the help of the programme committee, especially Nadja Braun and Thomas Buchsbaum, who were always available with their advice that helped shaping the workshop the way it is today.

Finally I would like to thank Terry Davis general secretary of the Council of Europe and Jürgen Weiss vice chairman of the Austrian Federal Council that the conference can take place under their auspices.

Vienna, August 2006 Robert Krimmer

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Content

Article IX

Krimmer, Robert and Melanie Volkamer. 2006. "Observing Threats to Voter's Anonymity: Election Observation of Electronic Voting." In *EGOV 2006*. Schriftenreihe Informatik 18. Linz: Trauner, 43-50. (3.2)

OBSERVING THREATS TO VOTER'S ANONYMITY: ELECTION OBSERVATION OF ELECTRONIC VOTING

Robert Krimmer[1], Melanie Volkamer[2]

Electronic Voting as one of the main applications of Electronic Democracy has come to the attention of many governments in their movement to modernize elections. Although very popular with many visionaries and politicians, there is a lot of controversy for the use of electronic means in elections. Especially in young democracies have to invite international election observer to raise the level of transparency and to calm discussions. There exists a lot of documentation and guidelines on the topic of election observation of paper based voting. As the observation of electronic voting processes is very new, there exists little to no experience with it. In this paper, the authors present a model how to detect threats to the voter's anonymity using common criteria methodology. The work is based on experience in the 2005 parliamentary elections in Venezuela as e-voting experts to audit the parliamentarian elections where e-voting machines with a voter verifiable audit trail were used[3].

1. Introduction

In the past years, many governments have started to adopt computer-supported applications for their administrative processes; applications range from the simple download of forms to Internet-based submission of applications. Amongst these, the most controversial application is electronic voting. Around the world, many experiments and reports on the use of electronic voting have been conducted. The several approaches can be categorized in: (1) Countries conducting voting in small binding field trials (France, Switzerland, United Kingdom); (2) Countries conducting non binding remote electronic voting tests (Austria, Denmark, Spain); (3) Countries that have implemented voting machines (i.e. India, Ireland, Germany, United States, Germany, Brazil, Venezuela) and (4) only Estonia has implemented remote electronic voting in their 2005 local elections as a legal binding voting channel available to any voter to date [For an overview see 1]. Although the worldwide approaches might be different in detail, all efforts still share the criticism by the public concerning the lack of transparency of the machines or applications itself. Recent studies by Oostveen and van den Besselaar [2] have shown that trust in e-voting is not dependent on the level of security but on the user's belief how secure the system is. This depends on the transparency of a system.

Traditionally countries that are considered to be young or so called transition democracies are expected to invite international election observers to guarantee for elections in accordance

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[3] The full version of this paper can be downloaded from www.e-voting.cc including an overview table with all threats, security objectives and observer tasks for election observation of e-voting.

with international standards. There exists a lot of documentation and guidelines on this topic how to observe traditional paper based voting. As the observation of electronic voting processes is very new, there exists little experience with it.

The authors therefore develop a model how to detect threats to the voter's anonymity based on experience in the 2005 parliamentary elections in Venezuela which uses e-voting machines with a voter verifiable audit trail. To do so, we first give a background on electronic voting in Venezuela, then describe the common criteria methodology and apply it to the e-voting process. Finally, we present the summarized model of how to observe elections with electronic voting machines.

2 Electronic Voting in Venezuela

The reasons why e-voting projects are of high disputes have their roots in the motives for starting such a project, which can be manifold. Amongst the most important are in accordance to [3]: enabling mobility of the voters, facilitating the participation in elections from abroad, reducing cost, raising voter turnout by offering additional channels, widening access for citizens with disabilities, delivering voting results reliably and more quickly. In transition democracies the last two reasons are especially important as they promise to solve on one hand problems with illiteracy of the population and on the other hand problems with infrastructure in regards to delivering the results in time.

In the 2005 Venezuela parliamentary elections, networked electronic voting machines were used that consisted out of two parts:

1. The Captahuella, which is a notebook with an attached fingerprint reader. The notebook has a database with a list of eligible voters and if available their fingerprints. The computers were used to identify the voter using his ID-card and to check the authenticity by comparing the fingerprint to the stored image. In case it was not available, it was captured for future comparisons. After the election was finished the machines would be connected to the central server to upload the data on who voted and who didn't. These machines were used only in part and for testing purposes.
2. The electronic voting machines itself, which were manufactured by Smartmatic, to cast the vote of the voters. Each of the 27.000 polling stations was equipped with one such machine. After the end of the election each machine was connected to the central counting server using cell phones, landlines or satellite connections to submit the votes to the server.

Although those machines were strictly separated and during the audits a flaw was found in the voting machines that would have allowed for reconstruction of the sequence the voters cast their votes. This then led to the removal of the Captahuellas as without it there was no automated way to register the sequence [4].

The problem with the feared secrecy of the vote was not the only problem in Venezuela but one major outcome of the observation mission. In order to come to such results in a structured way this paper proposes a model on e-voting observation. We use common criteria methodology to develop possible threats to the voter's anonymity and then to deduct the tasks for the observers to detect them. Although in this paper, the authors concentrate on networked electronic voting machines with connected identification and vote casting as intended to be used in Venezuela.

3. Developing the Methodology on how to Observe E-Voting

For analyzing electronic voting threats, we use the methodology of the internationally accepted framework of the Common Criteria (CC). These are the international standard (ISO 15408) for computer security. For our purpose, we work following CC-structure similar to a vulnerability and security analysis to:

1. define the security objective, i.e. which is to be protected,
2. analyze the possible threats (attacks) to these objectives,
3. approach these threats using functional or operation security functions,
4. check what the observer can do to check if the threats are handled OK.

The clear differentiation between the threats that have to be dealt with and the environment in which the system is run is a clear benefit from the common criteria formalization. This also helps to formulate the instructions to the observers.

3.1 Security Objectives

Electronic Voting has to meet the international election standards. Here the main one are the election principles which demand an election to ensure a free, secret, universal and equal election. In this paper, we want to concentrate on the election secrecy and the election freedom respectively. The secrecy objective as such is a very general objective which can be split up in more precise objectives:

1. The E-Voting system must ensure the link between the vote and the voter to be irreversible.
2. More precisely the secrecy of the vote has to be guaranteed during the casting, transfer, reception, collection and tabulation of votes. Very important in this point is that the secrecy must also be ensured at any time in the future [5] at least in case of parliamentary elections.
3. None of the actors involved in the voting process (organizers, election officials, trusted third parties, voters and attackers from inside and/or outside) is able to link the content of a vote to an identifiable voter.
4. No voter should be able to prove that he/she voted in a particular way, in order to prevent voter coercion and ballot buying.

3.2 General Threats

The following description of *threats* includes all threats to the election secrecy against which specific protection within an E-Voting system or within its environment is required. The attacker needs points in the voting process at which he gets information about the voter and his ballot as well. Thus, there are several points at which the attacker can try to interact:

- The attacker could physically observe the voter casting her ballot at the voting terminal.
- A Trojan horse on the voting terminal.
- Another point is sniffing on the network.
- Depending on the applied voting protocol the election servers are an attacking point.
- The Voter Audit Trail could also be used to link a voter to her vote.

In general, there are four different possibilities to link the electronic voter ID to her electronic ballot. The simplest one would be a messages consisting of both the voter ID and the ballot. Other possibilities are the protocol sequence, the time when the voter was identified and cast her vote, the IP addresses used to send first the voter ID and later on the voter's ballot.

3.3 Security Requirements

A good summery of relevant and common requirements can be found in [3]. In the following we will only take those into account which belong to the defined secrecy objectives. Here the generic requirement is defined as followed: “E-Voting shall be organised in such a way as to exclude at any stage of the voting procedure and, in particular, at voter authentication, anything that would endanger the secrecy of the vote.” We will have a more detailed look as it is also done in the catalogues and divide the requirements in *functional ones (F)* and those *to the environment (E)*. The observer has to verify both.

3.4 Observer’s tasks

The fourth and final step in our analysis is the definition of the observer’s tasks to be done during her observation mission. These concrete measures provide a basic checklist for the observer to check if her observations are complete or if there is a situation or check that has not been thought of and therefore completes our model to e-voting observation.

4. Analysis of the Threats to Voter’s Anonymity

In the following, we will discuss the threats and the attacks itself more in detail. Each threat is described in terms of an identified threat agent and the attack. Aspects such as expertise and available resources are addressed as well as attack methods and any vulnerability exploited. We deduce the functional and environmental requirements to list what the observer shall verify with respect to either the technical system or the operational and organisational environment and come up with recommendations to what to observe. Therefore, we will discuss each of the five general threats separately.

4.1 The Act of Ballot Casting and Anonymity

Threats. The most obvious threat to the voter’s anonymity is given in the polling station. The attacker could observe the voter casting her ballot at the voting terminal. There are two possibilities to do so. First, the attacker can be physically present at the polling station and looks over the voter’s shoulder. This would be quite obvious. However, an attacker could observe the voter casting her ballot from distance, e.g. through the window (T1). Second, the attacker could have installed a camera which films the voter casting her vote in the polling booth. In particular, the monitor of the voting terminal is filmed (T2). Even if both threats are not specific for Online-Voting - both are also applicable with in traditional ballot casting- an observer has to take these also into account.

Security requirements. From threat (T1) and (T2) which are very similar from their ideas we can deduce one requirement to the environment (E1): The terminal has to be applied in a secure environment with respect to personal and technical (e.g. camera) observation. Voters must not be able to observe each other and the electoral staff must not be able to observe the voter applying the election terminal (E2). There are special requirements for the position: e.g. the polling booth must not be situated next to a window to prevent observations from outside or next to steps where everyone who goes up- or downstairs can see how the voter votes.

Observer Tasks. Thus, the election observer has to control whether there is a polling booth (C1). In addition, she must check whether the polling booth is shaped in a way the voter can cast her ballot unobserved (C2). Moreover, the observer has to look for cameras (C3).

4.2 The Electronic Ballot Casting Device and Anonymity

Threats. In General, the voting terminal/device in an E-Voting System for polling stations is some kind of a computer (hardware and software components as well as an operating system). This computer must be connected to the Internet to check the voter's right to vote and in addition to transmit the ballot. The main problem is that terminals know the voter's ID and the voter's decision in plaintext. Thus, the attacker could try to manipulate the terminal in order either to forward the voter's ballot unencrypted together with the voter's ID to himself or to store the information at the terminal. In the latter case, the attacker needs access to the terminal to get the stored data, e.g. after the election or during the election with the help of a memory device (simply burnt on a CD at the terminal). The data (ballot and voter ID) can also be transmitted by other interfaces: e.g. Bluetooth or Infrared. Both forms of manipulations can be done by wrong voting software (T3) or by Trojan horses or other viruses (T4) on the voting device/ the computer. The Trojan horse could e.g. sniff the data from the input devices (keyboard and/or mouse) to get the voter's ID and voting decision in order to transmit it to the attacker. Thus, available sniffing Trojan horses have "only" to be modified a little bit. In the first case the attacker installs the wrong voting software – software whose user interface is similar to the correct one but with the additional function to transmit the ballot unencrypted together with the voter's ID to the attacker. The attacker has three possibilities to get the wrong software installed: First he could fake the delivered terminals by installing the wrong software. Second in case he is an eligible voter he could change the software when he is (unobserved) in the polling booth and last could substitute the correct software by the faked one remotely. In case of malware, the Trojan horse or other malware could also either be installed on the delivered voting terminal, by an attacker who is an eligible voter and has access to the polling booth, or by unauthorized remote access. Thereby it is easier to get a Trojan horse installed on the terminal than to substitute the whole or parts of the software.

Security Requirements. The terminal's deployment and delivery to the polling booth must be organized in a way that manipulation is excluded (E3). There must be a possibility to check if the terminal it self is an authorized one (E4). In addition, the system must provide a function to verify if the right voting software is installed (F1).

Observer Tasks. Before the election itself the observer has to ask for the delivery procedure and verify it (C4). An observer has to check whether the terminal is a correct one and not modified. This has to be done before and during the Election Day (C5). An analogously check for the correctness of the installed software has to be done before the election and several times during the Election Day (C6). So first of all the observer has to verify if the voting software itself ensures that the ballots and/or voter ID information is only sent encrypted and only addressed to the election servers. In addition, the respective information must be encrypted in a way that only the corresponding electoral server is able to decrypt the message. It must be checked that the software does not store the voter's ID and ballot on the terminal and in addition that these information are deleted irreversible. So, an attacker who has access to the terminals after the election does not get any information by analyzing its databases, memory and so on. Next, the election observer must have the possibility to verify if the software on the terminal is the one he checked and verified before. This could be done e.g. by a checksum generator. The observer must either check this value several times on the Election Day – in best case before each voter casts her ballot - or the system offers a mechanism that automatically verifies it. This software should also check if the whole terminal configuration is still ok. In addition, the observer has to verify whether the terminal prevents unauthorized Internet access (C7) to the terminal so that changing the software and the installation of malware can be excluded. To do so, she has to check:

- Is the applied Firewall and Virus Scanners the state of the art ones? Are they correctly configured?
- Are only the needed communication ports open and all others blocked?
- Is only those software installed which is needed?
- What kind of operating system is installed?

The best case would be a operating system which separate the software in a way that different software does not influence each other.

Moreover the election observer has to check whether an attacker has the possibility to modify the terminal by access in the polling booth (C8). So the terminal must only offer the voter/the attacker the possibility to authenticate and to cast a ballot. But it must not be made up of a whole keyboard and the voter has not the possibility to reboot the system. In addition the voter/attacker must not have access to the hardware or any external interfaces like any drive. In addition the election observer must verify that the terminal does not have any external transmission interfaces like Bluetooth and infrared. All the named checks could be simplified and reduced by the application of Trusted Computing. The observers also has to check if all locally stored data is deleted after the election using safe data disposal methods (C9).

4.3 The Voting Protocol and Anonymity

Threats. Another point to violate the voter's anonymity is sniffing on the Internet. The problem here is that the voter's ID as well as her (encrypted) ballot is sent over the Internet. The attack scenario is the following one: The observer sniffs all voting protocol messages transmitted to the electoral server, stores these data in a database, and analyses them after the election (T5). He can sort the messages by the messages' timestamp. So, that he knows the whole protocol for each voter. But, the attacker does not know which message block can be assigned to which voter, because these messages are encrypted - encrypted with the state-of-the-Art encryption algorithms. The problem with respect to the anonymity requirement is that the chosen algorithms are classified to be secure for the present but no statements for the future can be made. On the one hand single protocol messages can always be decrypted by using adequate computational power e.g. by Brute Force trials. And on the other hand all messages can be encrypted in arbitrary time when someone finds a fast algorithm to decrypt messages without the knowledge of the secret key. Thus, depending on the attacker's computational power, he will be in a position to decrypt all or at least single encrypted ballot messages after the election. When this future date will be depends on the strength of the encryption function. At some point in the future the networking observer is able to link a decrypted ballot to a voter. Thus, the temporal unlimited election secrecy is not ensured against such a network attacker. The chosen attack potential is quite high, but the attack is in general not impossible. At least within political elections we keep it in mind.

Security Requirements. The communication between the E-Voting clients and the servers should be done in a network that limits possibilities of sniffing by external (E5).

Observer Tasks. So, the question to be answered by the election observer for the individual voting protocols is, whether the sniffing attacker is able to link the decrypted vote to an identified voter or whether he only gets decrypted ballot messages but cannot link these to single voters. Therefore the timestamp must get useless. The election observer has to verify if the applied protocol and system setup prevents the violation of the voter's anonymity in an adequate way (C10). This could be done e.g. by a special secure network or the application of mix networks. So, all protocol messages pass a mix or a mix cascade, which forwards several messages at the same time to the electoral server. Here the sniffing nodes are limited and the

observer has to sniff on nodes before the first mix because behind the messages are make anonymous by mixing the messages. So it gets more difficult for the sniffing attacker because he cannot sniff at an arbitrary node. The time constraints are the problem with this approach. The mix will only start working when he received several protocol messages. Thus the voter in the polling booth can only continue when some other voters vote at the same point of time. Another possibility is to meet the anonymity problem on the protocol layer is the local storage of the ballots. The stored ballots are either transmitted all at the end of the Election Day or they are transmitted in blocks of ballots as introduced in [6]. Within the latter solutions the election observer has to ensure that the software randomly mixes the ballots before storing them locally or sending them to the electoral server (C11) [3, 7].

4.4 The Electoral Server and Anonymity

Threats. The election servers are yet another attacking point. The attacker could either attack both the election register as well as the ballot box. From the first server he might get the allocation [voterID, terminal-number, time] and from the ballot box the allocation [terminal, time, ballot] or at least [terminal, time, encrypted-ballot]. With this knowledge the attacker can either directly allocate a voterID to a ballot or he is able to do so, when he is able to decrypt the corresponding ballot (T6). Another possibility is that the attacker only get access to the ballot box but in addition he can observe who cast her vote at what time in a particular polling booth (this is possible because the polling station is a public place) (T7). Here he allocates his observing knowledge [voter, terminal-number, time] with the allocation from the ballot box. In both case the attacker is able to break the anonymity. Just like with the terminal security the attacker could try to get physical access to the server or by the Internet. He can try to transmit the information or get it by physical access (T8).

Security Requirements: The administration of both the E-Voting machines and the Servers has to make sure no person is able to access the data (E6). In addition the system must provide for a safe data disposal procedure a reasonable time after the election (F2)

Observer Tasks. Researchers and system developers come up against this threat with organizational measures, e.g. access control based on the four-eyes-principle [8]. The election observer has to check if such concepts are implemented (C12). In addition he has to verify that the ballot box deletes information e.g. about time and the terminal in an irrevocable way (C13). So, only the ballot is stored. To prevent access to it the server has to provide the same security measures as the terminal (C14). This has to be checked by the election observer. Furthermore the observer has to check that all data on the respective systems are safely disposed a reasonable time after the election because this data stored in separate locations (registration and ballot box servers, clients) could be used to link the voter to the vote (C15).

4.5 Other Anonymity Threats: Voter Audit Trails

Threats. Some voting systems offers voter audit trail [9] to increase the voter's confidence to the new election system. Hereby the voters get some information either on paper or digital information. The voters check if the information on the paper is the same as on the E-Voting Machine and later put in a separate ballot box so a recount is possible. The problem is that the audit trail could be used by the voter to prove against other her decision (T9). Such an audit trail could be used for ballot buying.

Security Requirement: The voting process in the polling station should be organized in that way that no voter can leave the station without putting the voter audit trail paper in a separate ballot box (E7). The system must provide a way so the voter audit proves the decision (F3).

Observer Tasks. In any voting system that provides a voter audit trail, the election observer has to check if the received recipe can be used to prove the decision (C16). This could be done either by cryptographic functions or by paper audit trail, which the voter has to through in the urn box before leaving the polling station. In the first case, the voter's decision can only be verified with the help of an electoral device but otherwise not, e.g. because the information is decrypted or it is stored on a device that can only be read by the electoral device. In the later case the paper ballots can be counted in case there are problems with the E-Voting system or if someone mistrusts the electronic result. Further, the observers have to check the layout of the polling stations so no voter is able to take the audit paper with her (C17).

5. Conclusion

The method we presented here is a based on the experience made in the Venezuelan election. The method presents a way to verify if threats to voter's anonymity in an election using Electronic Voting Machines have been addressed adequately or not. Still the described checks are difficult to perform as not all data might be available or not everything can be observed due to local traditions (as it was the case in the above election). A lot of help would be if the Electronic Voting Machines have been certified and developed using common criteria. In this case the observers would only have to check the CC inspection report and security target of the machines to check if all necessary measures have been taken. Then the observing task could concentrate on the part in the polling stations and would not have to stick to software evaluations. One point that is open for discussion is, whether the observers should only check concepts or if they should also check the source code for the right implementation of the concepts. Further, the observer also has to define the attacker potential because this allows for elimination of some threats, as the attacker is not able to conduct the described attacks. We are sure that this model of observing e-voting helps in raising the transparency in elections using electronic devices and lead to higher confidence of the voters in the democratic system.

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Article X

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The E-Voting Readiness Index

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Abstract: The goal of this study is to analyse and compare the environment for the introduction of E-Voting. To do so a contextual model is developed and then applied with the value benefit analysis to compare 31 countries including all EU member states, and Russia, Switzerland, United States and Venezuela.

1 Introduction

The use of information and communication technology (ICT) in the electoral process is continuously rising around the world. While most of the applications emerge in the back-office, hence the administration of the election like electronic electoral registers or mandate calculate, ICT is finally reaching the home of the voters.

As can be seen in international gatherings of E-Voting experts, the discussion around is led very actively. The use of E-Voting machines has taken up in many countries, the uses of E-Voting in remote elections is in contrast still small in size [KTV07].

So far there has been only one study by Leenes and Svensson which could not identify a unique trend for the adoption of E-Voting other than that it is dependant from the context [LeSv03].

In the following we will introduce the methodology and give some first findings of our study.

2 Methodology

For our analysis of the E-Voting context, we needed on the one hand the contextual model where we identified the necessary dimensions to be used, and on the other hand the methodology to assess the countries.

2.1 Contextual Model

For the development of a contextual model for E-Voting we could use previous work, namely the work by Leenes/Svenson [LeSv03] and Moosmann/Baumberger [MoBa03]. These were integrated in our first approach as described in [Krim04], where four dimensions were identified: the political, legal, technological and social dimenions. These factors constitute the national (macro) level in contrast to the process (micro) level for the concrete application under investigation. These dimensions were also broken down in subdimensions.

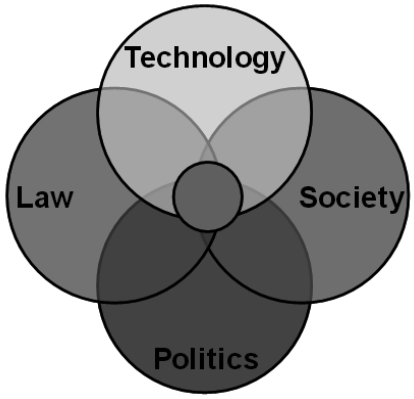

Figure 2: The Dimenions of E-Voting

We then extended this model using Pippa Norris's view [PiNo01, 11] where she distinguishes among three nested levels of analysis, as illustrated in figure 3. The national context, including the macro-level of technological, socioeconomic, and political environment, determines the diffusion of the Internet within each country. These three environments are similar to those from the previous model. The institutional context of the virtual political system provides the structure of opportunities mediating between citizens and the state, including the use of digital information and communication technologies by governments and civic society. Here the political process takes place. The individual or micro-level of resources and motivation determines who participates within the virtual political system. Norris' framework assumes that the national context, such as the process of technological diffusion, influences the development of the virtual political system. In turn, the core institutions of the political system available in the digital world provide the systematic context within individual citizens have opportunities to participate online. It is determined by the particular citizen, personal resources (time, money, skills) and their motivation to take advantage of these opportunities.

The final model consists of two levels to be explored:

- National level (Macro)
- Application level (Micro)

While the national level handles with E-Democracy environment in general, the level on project basis examines the application E-Voting. Regarding E-Democracy, the dimensions on the national view level which can be considered are divided as figure 3 shows:

- Information Society Context
- Political Context
- Legal Context Information

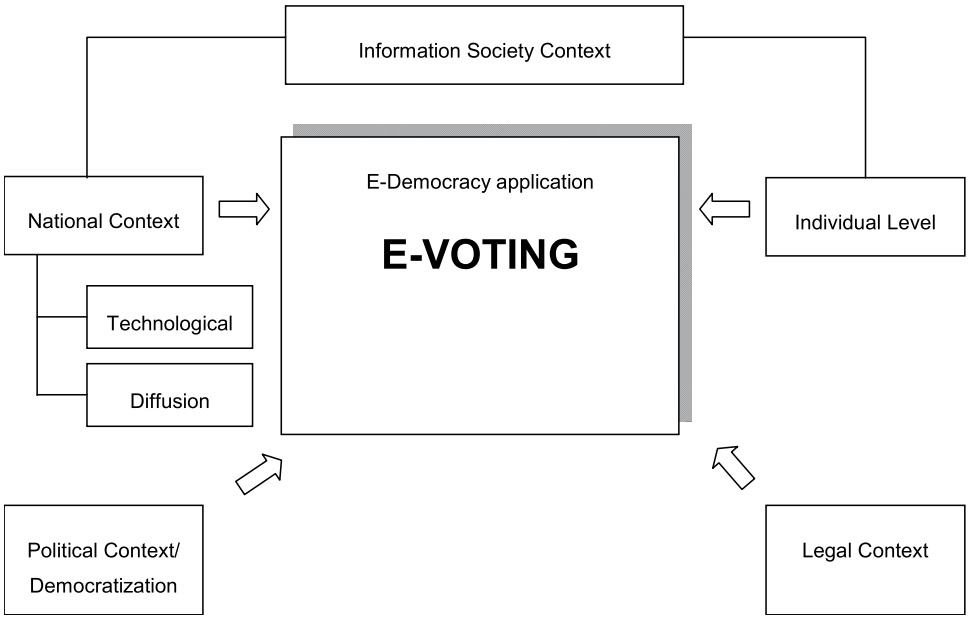

Figure 3: The E-Voting Readiness Index Contextual Model [RoSc07, 16]

The “information society context” is divided into “national context” and the “individual context” of the users whereby the latter is not considered in this work. The “national level” is further divided into “technological” and “diffusion”. In this dimension there are items like computer penetration, internet penetration to be measured as E-Democracy is an IT topic.

The “political context” considers the democratization of a country by measuring subdimensions like “institutional stability” or “stateness”. A stable democracy is necessary for the introduction of E-Democracy applications like E-Voting.

The “Legal Context” measures basics for democratic elections like election system or supplementary protocol for human rights that are required by a democracy.

Those dimensions that are relevant for E-Democracy have a great impact on a possible application like E-Voting. The result of the first stage “national view level” can be considered as an E-Democracy readiness scale.

The second stage to be measured is the application level with the application E-Voting that is influenced by the environment. This stage is divided into public and private projects to guarantee that individual experiences are not mixed with the development progress of the state and completes the E-Democracy readiness scale of the first stage to a complete E-Voting readiness scale.

For each of the dimensions numerous weighted indicators have been found that were grouped to weighted subdimension that are summed up to the dimensions. By summing up the weighted dimensions the E-Voting readiness can be explored.

The next table shows the dimensions and it’s subdimensions used.

	E-Democracy Environment			Application E-Voting
DIMENSIONS	Information Society Context	Legal Context	Political Context	E-Voting Applicaton
SUBDIMENSIONS	Status of registers	Election System	Stateness	Public debate
	Status of eGovernment infrastructure	Supplementary protocol for human rights	Rule of law	Private elections
	Digital net infrastructure	Realization of Council of Europe recommendation	Stability of democratic institutions	Public elections
	Prices for the entrance to information and communication service and for the use of services		Election system and turnout	
	Diffusion of information and communication services		Politicial participation	
	Expenditures for information technologies and information and communication-referred services		Political aims	
	Transaction penetration			
	Degree of the informatization in the public administration and of administrative expirations			

Table 1: The Factors for the E-Voting Readiness Scale

2.2 Methodology

The requirement was to find a method that allows the analysis of different opportunities to reach a defined goal. Zangemeister's basic system of the value benefit analysis turned out to be useful setting up our methodology. He regards his method as analysis of a quantity of complex alternatives with the purpose of arranging the elements according to the preferences of the decision maker. Phases proposed are: (i) Definition of situation-relevant goals, (ii) description alternatives to reach a goal, (iii) a preference order of the alternatives due to the goals that have to be achieved. [Zang76, 45]

Using the value benefit analysis it becomes possible to include the non quantifiable use into an evaluation with and thus to eliminate the main difficulty creating costs using comparisons. We used the more specified approach from Stahlknecht and Hasenkamp [StHa05] who applied the value benefit analysis for assessing tenders in the IT-sector.

1. Listing and weighting of the criteria. The criteria relevant from the view of user are arranged and weighted proportionally. The sum of the weighting results in 100 percent.

2. Confrontation of the units of analysis. The units are confronted on the basis of the selected criteria.

3. Evaluation and scoring of the units of analysis. Each unit is evaluated regarding each criterion. The values are then multiplied according to the associated weights and the final values are added. Thus result into the individual utilizable value of the alternative.

We adapted this approach for our purposes as follows:

1. The superordinate goal is the development of the E-Voting readiness scale. In order to develop this scale, the relevant environmental dimensions must be identified (see 2.2).

2. Dimensions are divided into thematically matching subdimensions. These sub-dimensions contain the individual indicators. Each indicator is evaluated on a four-level scale, whereby alternative 1 describes the least favorable environment situation and therefore gets only 0,25 points and alternative 4 is the most favorable environment situation and gets 1 point.

3. Since the individual indicators do not have the same importance for the evaluation of a subdimension, these are weighted. The sum of the weighted criteria results in a number for the subdimension.

4. The subdimensions are weighted too as their contribution to the utilizable value for the dimensions are different. The sum of the weighted subdimensions is a number for the whole dimension expressing the utilizable value for the environment of the whole dimension.

5. Finally the different dimensions have to be weighted according to their importance of contribution to the E-Voting readiness. The sum of the weighted dimensions results in a number that expresses the E-Voting readiness.

The following figure represents this procedure.

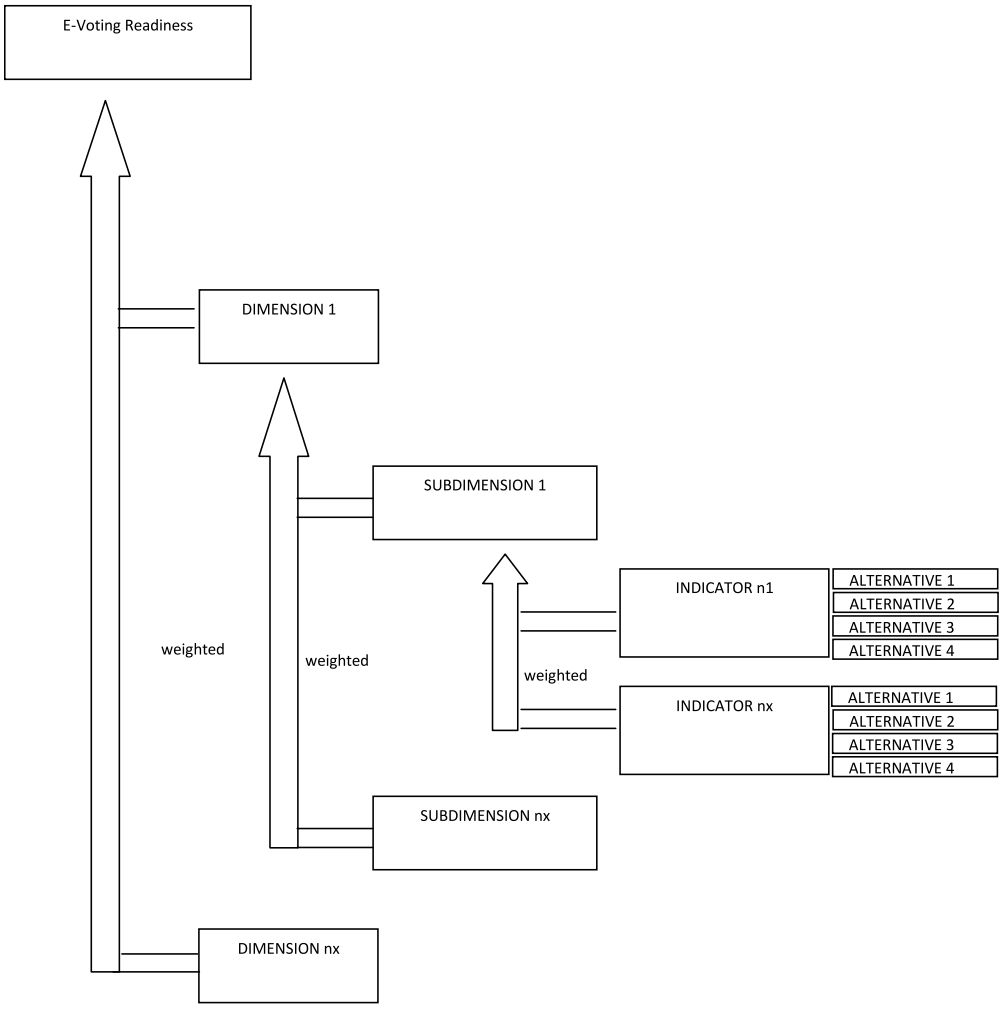

Figure 1: The Evaluation Procedure for the E-Voting Readiness Scale following the Value Benefit Analysis

3 Study

We used the above described methodology of a value benefit analysis together with the contextual model to answer our main question, which is to measure the progessiveness of countries in preparing the right context for E-Voting. To do so, we developed factors for each of the subdimensions to determine and measure the criteria. In the end we had 79 single factors (Political Context: 16, Legal Context: 10, Information Society Context: 29, E-Voting: 24). The next step was the weighting of the (sub) dimensions, and factors. We weighted the E-Voting with 40% and each of the three macro levels with 20%.

In the next step we identified 31 countries for the study. We included all 27 member states of the European Union, as well as relevant countries with E-Voting experiences where data was available: Russia, Switzerland, United States and Venezuela. The research team was extended by IT experts with native language skills and then used desktop research to collect the data and assessed the factors between 0,25 to 1.

As an example we will walk you through the process of classifying relevant dimensions with the example of Great Britain.

In order to be able to evaluate specific items we consulted research articles, press releases, experts and different sources in the World Wide Web. All data were collected twice. If we had divergences in data material we started further investigations.

The political context of Great Britain is well developed. Indicators evaluating the fields of constitutional state, stability of democratic institutions, political participation and political aims were scored at highest levels. We found restrictions in election turnout.

The legal context of Great Britain shows an excellent environment for E-Voting. We did not find any restrictions in the election system. There is no postal voting implemented, but advanced voting exists.

Concerning the IS context the major findings were: No citizen register is implemented. The voting register is organized de-central and electronically. Registration procedure for elections is the responsibility of government authorities. Digital signature is available. A Citizen card is considered to be introduced soon. E-Government standards are implemented. Indicators for penetration of computers, internet and mobile phones show values of 44.8 percent, 67 percent and 109 percent. Further internet transactions like online shopping and e-Government applications have been executed on a high level by citizens shortly below 40 percent. Just eight percent handle their finances electronically.

Great Britain tested all kinds of electronic voting: Voting machines, kiosk voting and I-Voting. There have been private electronic elections. Politically binding elections fulfill the comprehensive British experience: Voting machines in polling stations, kiosk voting and remote electronic voting.

The study resulted in the following weighted factors according to the four dimensions:

	Political	Legal	InfSoc	E-Vote	Total
Austria	19,58	14,20	14,04	12,13	59,96
Belgium	20,00	11,40	10,20	15,35	56,95
Bulgaria	15,33	8,40	4,17	1,47	29,37
Cyprus	14,58	8,40	5,19	0,00	28,17
Czech Republic	18,23	8,40	8,05	2,37	37,05
Denmark	20,00	17,00	8,99	8,55	54,54
Estonia	17,88	16,76	14,36	17,60	66,60
Finland	19,08	14,20	10,64	12,87	56,79
France	19,50	8,40	9,23	19,53	56,66
Germany	19,50	14,20	10,37	15,00	59,07
Greece	18,88	8,40	6,45	7,50	41,23
Hungary	19,00	8,40	9,41	2,50	39,31
Ireland	18,90	10,40	6,63	6,93	42,86
Italy	16,10	8,40	7,76	14,80	47,06
Latvia	18,00	8,40	4,76	3,47	34,63
Lithuania	17,00	8,40	5,23	5,47	36,10
Luxembourg	20,00	11,20	10,17	0,37	41,74
Malta	19,40	11,40	4,44	3,10	38,34
Netherlands	20,00	14,20	8,80	19,90	62,90
Poland	17,67	8,40	4,89	2,92	33,87
Portugal	19,00	11,20	7,92	14,92	53,04
Romania	15,38	8,40	4,97	5,13	33,88
Russia	13,57	8,40	5,61	10,30	37,88
Slovakia	15,27	16,30	6,07	6,57	44,20
Slovenia	19,00	11,20	6,01	4,35	40,56
Spain	18,08	8,40	9,44	17,43	53,36
Sweden	20,00	17,00	11,39	11,50	59,89
Switzerland	19,00	14,00	10,39	18,40	61,79
United Kingdom	19,15	11,50	8,60	31,35	70,60
United States	18,50	16,30	8,18	23,70	66,68
Venezuela	11,68	8,40	6,88	11,60	38,57

4 Conclusion

This project was an ambitious effort to the development of the contextual model and to collect the data. However the collected data and analysis will provide for a better understanding of the environment for E-Voting and in consequence it will benefit future research in the area. The future work will concentrate on finding significant relations between contextual factors and successful deployment of E-Voting.

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3. Education

1996-2002	WU Vienna University of Economics and Business Administration, *Master of Business Administration*
1999	New York University Leonard N. Stern School of Business, *International Management Program*

4. Language skills

German	native language
English	bi-lingual
French	intermediate
Polish	beginner

5. Special courses

2006	DEMO_net PhD Workshops in Krakow, Poland, in September, and in Athens, Greece, in December 2006
Summer 2003	ESF Summer School on Towards Electronic Democracy (TED): Internet-Based Decision Support, Varenna, Italy, 7-13 September 2003

6. Professional employment

2010-	Organisation for Security and Co-Operation in Europe (OSCE), Office for Democratic Institutions and Human Rights (ODIHR), *Senior Adviser for New Voting Technologies*
2006-2010	E-Voting.CC Competence Center for Electronic Voting and Participation, *Managing Director and Founder*
2006-2007	Institute for IS Research, University of Koblenz, *Assistant*
2004-2005	Institute for Informatics in Business and Administration, University of Linz, *Assistant*
2001-2004	Department Production Management, Institute for Information Management and Systems, WU Vienna University of Economics and Business, *Project Assistant*

7. Scientific projects

2006-2008	E-Voting Readiness Index – Analysis of Influencing Factors of Electronic Voting Deployment in 33 Countries
2006-2007	DEMO_net – EU 6th Framework Network of Excellence on Electronic Participation
2005-2007	Analysis of Internet Voting Use around the World
2001-2004	E-Voting.at: Development of an Internet-based Electronic Voting Prototype

8. Defended theses

Thesis: E-voting.at: Electronic Democracy demonstrated at the Example of the Austrian Federation of Students' Elections (original title: "E-Voting.at: Elektronische Demokratie am Beispiel der Österreichischen Hochschülerschaftswahlen")

9. Honors and awards

2003	Scientific Award, BMW Group, 2nd Prize Diploma Thesis
1999	International Student Leadership Award, New York University

10. Main areas of scientific work

E-voting and especially Internet voting, interdisciplinary research involving technical, legal, political and social issues in developed and transitional democracies, e-participation, e-democracy, and e-government research

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3. Ausbildung

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4. Sprachfähigkeit

Deutsch	Muttersprache
Englisch	Zweisprachig
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5. Spezialkurse

2006	DEMO_net Doktoratsworkshops im September in Krakau, Polen, und im Dezember 2006 in Athen, Griechenland
Sommer 2003	ESF Sommerschule zum Thema Am Weg zur elektronischen Demokratie (TED): Internetbasierte Entscheidungsunterstützung, in Varenna, Italien, von 7. bis 13. September 2003

6. Berufliche Qualifikation

2010-	Organisation für Sicherheit und Zusammenarbeit in Europa (OSZE), Büro für Demokratieinstrumente und Menschenrechte (BDIMR) (ODIHR), *Senior Berater für Neue Wahltechnologien*
2006-2010	E-Voting.CC Kompetenzzentrum für elektronische Wahlen und Partizipation, *Geschäftsführer und Gründer*
2006-2007	Institut für Verwaltungs- und Wirtschaftsinformatik, Universität Koblenz*, Assistent*
2004-2005	Institut für Informatik in Wirtschaft und Verwaltung, J.K. Universität Linz, *Assistent*
2001-2004	Abteilung Produktionsmanagement, Institut für Informationssysteme, Wirtschaftsuniversität Wien, *Projektassistent*

7. Wissenschaftliche Projekte

2006-2008	E-Voting Bereitschaftsindex – Analyse der Einflussfaktoren für den Einsatz von Elektronischen Wahlen in 33 Ländern
2006-2007	DEMO_net – EU 6. Rahmenprogrammprojekt Exzellenznetzwerk zu Elektronischer Partizipation
2005-2007	Analyse des Einsatzes von Internetwahlen in der Welt
2001-2004	E-Voting.at: Entwicklung eines Internetbasierten Elektronische Wahlprototypen

8. Wissenschaftliche Arbeiten

Diplomarbeit: „E-Voting.at: Elektronische Demokratie am Beispiel der Österreichischen Hochschülerschaftswahlen“

9. Auszeichnungen

2003	Scientific Award, BMW Group, 2. Preis Diplomarbeit
1999	International Student Leadership Award, New York Universität

10. Wissenschaftliche Interessen

E-Voting und Internetwahlen im speziellen, interdisziplinäre Erforschung von technischen, rechtlichen, politischen und gesellschaftlichen Aspekte der elektronischen Wahlen in entwickelten und transformierenden Demokratien, E-Partizipation, E-Demokratie und E-Government

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4. Keelteoskus

saksa keel	emakeel
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poola keel	algtase

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2006	DEMO-net PhD töötoad Krakovis (Poola) septembris ja Ateenas (Kreeka) detsembris 2006
suvi 2003	ESF suvekool teemal "Elektroonilise demokraatia suunas: internetipõhine otsusetegemine" Varena (Itaalia) 7-13 september 2003

6. Teenistuskäik

2010-	Euroopa Julgeoleku- ja Koostöö-organisatsioon (OSCE), Demokraatlike Institutsioonide ja Inimõiguste Keskus (ODIHR), *vanemnõunik uute hääleta-mistehnoloogiate alal*
2006-2010	E-Voting.CC E-valimiste ja osaluse Kompetentsikeskus, *asutaja ja tegev-juht*
2006-2007	ISi Uuringute Keskus, Koblenzi Ülikool, *assistent*
2004-2005	Linzi Ülikooli Ärinduse ja Halduse Informaatika Instituut, *assistent*
2001-2004	Viini Majandus- ja Ärijuhtimise Ülikooli tootearendusosakond, *projekti assistent*

7. Teadustegevus (osalemine teadusprojektides)

2006-2008	E-hääletuse valmisolekuindeks – elektroonilise valimise kasutamist mõjutavate faktorite analüüs 33 riigis
2006-2007	DEMO_net – ELi 6. teadusuuringute raamprogramm elektroonilise osaluse täiustamiseks
2005-2007	Internetivalimiste kasutamine maailmas
2001-2004	E-voting.at: internetipõhise hääletus-prototüübi arendamine

8. Kaitstud lõputööd

"E-Voting.at: Elektronische Demokratie am Beispiel der Österreichischen Hochschülerschaftswahlen" *(Master of Business Administration)*

9. Tunnustused

2003	Teadusauhind, BMW Group, 2. koht diplomitööde kategoorias
1999	*International Student Leadership Award*, New York University Leonard N. Stern School of Business

10. Teadustöö põhisuunad

E-hääletamine põhisuunaga internetihääletamisel, interdistsiplinaarne teadustöö tehnilistes, õiguslikes, poliitilistes ja sotsiaalsetes küsimustes arenenud ja üleminekudemokraatiates, e-osalemine, e-demokraatia ja e-valitsuse uuringud.

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