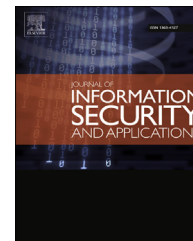




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# Implementing and evaluating a software-independent voting system for polling station elections

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## ABSTRACT

In 2009 the German Federal Constitutional Court introduced the principle of “public nature of elections” (Federal Constitutional Court of Germany, March 2009). This principle requires that when using electronic voting systems it must be possible for the citizen to verify the essential steps in the election process and in the ascertainment of the results reliably and without special expert knowledge. Unfortunately, none of the existing systems complies with this principle. As a result, the use of electronic voting systems in Germany for parliamentary elections has stopped. Nevertheless, electronic voting systems are necessary and would improve the situation, especially for elections with complex ballots and voting rules, for example some local elections in Germany or parliamentary elections in Belgium and Luxembourg. The concept proposed by Volkamer et al. (Volkamer et al., 2011) was analyzed by a legal expert and evaluated to comply with the German legal requirements for local elections in the state of Hesse (Henning et al., 2012). In this paper we specify and concretize processes that were left open in the concept, and implement a prototype. We evaluated this prototype in a user study that was conducted alongside the university elections at the Technische Universität Darmstadt in June 2013. The results of the study show that most of the participants were satisfied with the prototype and would support its use for the upcoming university elections. We also report some lessons learned.

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## 1. Introduction

Electronic voting continues to be a topic of interest with widespread use in different contexts and countries. While countries like U.S., Estonia, Norway, Switzerland, and Finland use electronic voting for legally-binding elections, others such as the Netherlands and Germany have stopped their use, due to legal requirements.

Germany seems to have the strictest legal requirements with respect to the use of electronic voting systems in legally-binding elections. Electronic voting systems have to comply with the principle of “public nature of elections”, which was introduced by the [Federal Constitutional Court of Germany in 2009](#). Hence, when using an electronic voting system, it must be possible for the citizen to verify the essential steps in the election act and in the ascertainment of the results reliably and without special expert knowledge. This holds true for

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federal, state and local elections in Germany. The use of electronic voting systems in Germany is especially necessary for local elections with complex ballots and voting rules, for example local elections in Hesse. To the best of our knowledge, the concept introduced by Volkamer et al. (2011) is the only one that has been analyzed by a legal expert with respect to, and evaluated to comply with, the German legal requirements for local elections in Hesse (Henning et al., 2012).<sup>1</sup> However, before this concept can be used in such elections, a number of processes need to be concretized, specified and implemented.

Volkamer et al. (2011) proposed the printing of multiple paper ballots in the vote casting process, but this was not concretized. Hence, we concretized the vote casting process by comparing advantages and disadvantages of multiple versus single printouts. From a concept level the following processes need to be specified:

- Enabling/disabling the voting device.
- Preventing permanent storage of votes.
- Ensuring physical security.

Afterward, we implemented a prototype, in order to evaluate the electronic voting system and to improve our technical approaches. To enable the use of the prototype in user studies, we also developed adequate user guidelines/procedures for voters and poll workers. Furthermore, we conducted a user study alongside university elections at the Technische Universität Darmstadt in June 2013. The focus of the user study was to evaluate the voting phase, while an implementation and evaluation of the tallying phase is left for future work.

## 2. Concept: EasyVote

The EasyVote concept proposed by Volkamer et al. (2011) mainly addresses challenges in elections with complex ballots and voting rules, e.g. some local elections in Germany or parliamentary elections in Belgium and Luxembourg. However, this concept is applicable to any type of elections. The novelty of EasyVote is that it combines the advantages of the traditional paper-based system and those of an electronic voting system. Furthermore, according to the definitions of Rivest and Wack (2006) EasyVote is software-independent.

### 2.1. Voting phase

The voter first identifies herself to the poll workers, similar to traditional paper-based elections. Afterward, the voter enters the voting booth and uses the electronic voting device to prepare the ballot by selecting candidates. When the voter confirms the selected candidates, the electronic voting device starts the printing process and at the same time deletes all electronic data, i.e. all voter's selections.<sup>2</sup> The printout, which contains voter's selections, consists of two parts: a human-readable and a machine-readable (a QR-Code) part.<sup>3</sup> The voter verifies that the human-readable part contains the candidates selected on the electronic voting device. Finally, the voter folds the printout, leaves the voting booth and deposits the printout into the ballot box. The components used in the vote casting process, are shown on the left side of Fig. 1.

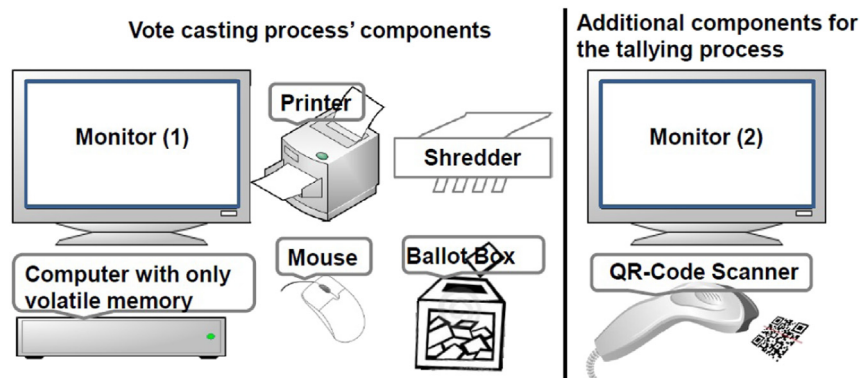


Fig. 1 – EasyVote components.

<sup>1</sup> As (Henning et al., 2012) is in German, we provide here a short summary: 1) Voters can verify their printouts without any specialist knowledge and without relying on the system's integrity. Independent of the QR-Code, the human-readable part is determinative. 2) The system enables a fully manual counting, similar to the traditional one. 3) The system strengthens the principle of "public nature of elections", because voters better understand the impact of their selections, and the tallying process might be faster than in traditional system.

### 2.2. Tallying phase

Similar to the traditional paper-based system, poll workers first open the sealed ballot box, and verify that the number of printouts (paper ballots) matches the number of voters in

<sup>2</sup> At this point in time, data are deleted from the vote casting software, i.e. on the software level.

<sup>3</sup> The machine-readable part, which contains the exact information as the human-readable part, enables an automatic tallying of the printouts.

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