Direct recording electronic voting systems: The future of elections?

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October 8th, 2004

1 Introduction

Americans pride themselves on their democracy–every citizen has one voice and one vote. Ensuring that every vote is counted and recorded fairly and accurately is the job of various election commissions. Nationwide, election commissions have been switching from traditional paper ballots, punch-cards, and mechanical-levers to new direct recording electronic (DRE) voting systems. DRE system manufactures promise to reduce voter error, improve accessibilty for the disabled, and completely eliminate the need for paper or levers [1]. Studies of a popular and widely-deployed DRE system, however, have revealed many oversights that undermine both the experts' and the voters' confidence in the system [1, 2].

1.1 Background

In 2000, the presidential election between Vice President Al Gore (Democrat) and Texas Governor George W. Bush (Republican) came down to one state–Florida. Since Florida's poll results would determine who won the presidency, accurate vote counting was essential [3]. When the polls closed, about a thousand votes separated Gore from Bush and the presidency. The Gore campaign lawyers demanded the State of Florida recount the ballots in several closely contested counties. These recounts were eventually ceased by the Supreme Court of the United States, and George W. Bush became the Forty-Third President of the

United States [1].

Interest in DRE systems grew rapidly after Florida's 2000 presidential election contro- versy. The controversy stemmed from confusion over the now infamous butterfly ballots. The butterfly ballot's complex layout of easily dislodged chads (punch holes) confused both voters and election officials. Voters had little means of verifying which candidate they had voted for, election officials were hardpressed to determine the "voter's intent", and Americans lost faith in the system [4].

In response to America's loss of faith in punch-card voting systems, the government passed the Help America Vote Act of 2002 (HAVA) which provided US$3.8 billion to fund election upgrades [4]. HAVA requires all states to replace their punch-card and mechanical- lever[2] systems with more reliable systems. Paper ballots are not required to be replaced since most constituencies use paper ballots for absentee voters.

A popular choice for states upgrading their voting systems is the optical mark-sense voting system [4]. Optical systems should be familiar to anyone who has taken a standardized test (SAT, ACT, etc) within the last couple of decades. An optical scanner scans the ballot looking for a specific marking indicating the voter's choice[3]. While optical scanner technology has improved vote count accuracy, optical systems are not without faults. Voters who leave erroneous marks or fail to completely mark their ballot inadvertently cause the scanner to misinterpret their vote [4].

1.2   Problem definition

As a means of addressing many of the problems associated with older voting systems, com- panies such as Diebold and VoteHere have unveiled DRE systems that promise to eliminate nearly all sources of voter and tabulation error [2, 5]. These DRE systems present the voter with a user-friendly interface; guide them through the voting process through verbal and visual prompts; and allow the voter to confirm their ballot before the selections are digitally recorded and transmitted to a central location [2, 4]. Ensuring the security and accuracy of the digital records is essential for DRE systems to be trustworthy. Trust, however, is lacking–from both voters and experts.

Distrust for DRE systems is not without just cause. Voters trust traditional voting sys- tems like paper ballots, punch-cards, or mechanical-levers because they are familiar. Voters are familiar with the process of voting and the mechanisms involved. When something

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[1]Official results: Florida: Bush–2,912,790 votes; Gore–2,912,253 votes. National: Bush–50,456,002 votes (271 Electoral College votes); Gore–50,999,897 votes (266 Electoral College votes) [3].

[2]Voters pull the lever associated with their candidate of choice incrementing a counter. Once the voter is done, the levers are automatically reset [4].

[3]Examples include completing an arrow or filling a circle next to the candidates name [4].

goes wrong, voters know whom to contact or hold accountable–poll workers or local election officials–thus providing one means of audit [4]. With paper-based voting systems, the voter knows that a physical record of their vote exists; loss or tampering of the record would leave physical evidence. Furthermore, paper-based voting systems allow for a recount at the level of individual votes [6]. Therefore, if any controversy or allegations of fraud arise, an audit of the system would either confirm the validity or discover errors with the vote count.

With mechanical-lever systems, no physical evidence of any single vote exists, and as such, meaningful recounts are impossible [6]. Since a recount would consist of opening up each machine and rereading the vote totals, any flaws with the original count would be duplicated in the recount. These flaws could include deliberate tampering or general, mechanical faults with machines. However, poll-workers inspect the machines prior to opening the polls, audit their mechanisms, and remove faulty machines. Voters assist with this audit by reporting machines that break during the course of the election [4].

Physical records of votes do not exist in a DRE system and tampering is almost undetectable. As a result voters are uncertain if their vote was recorded properly or at all. This uncertainty stems from the "black-box" nature of DRE systems. DRE systems present the voter a user-friendly interface, but the voter has no idea how the system operates internally. All operations done by the DRE system are dictated by the system's source code, and analysis of Diebold's AccuVote-TS source code has revealed countless flaws [2]. Recent lawsuits against Diebold[4] [7] and VoteHere[5] [5] further emphasize the fundamental flaws of DRE systems. Despite these flaws and lack of audit mechanisms, the increased popularity of DRE systems means that they will soon become commonplace in the polling booth.

1.3   Proposed objectives

If DRE systems are here to stay, a major effort must be undertaken to improve the security and accountability of the systems and their manufacturers. Security can be improved by limiting the number of tasks a DRE system is allowed to perform. Fewer tasks means more attention can be paid to securing critical functionality [2]. Even if the critical functionality is compromised, adding a means of audit can quickly expose problems. One suggested means is through the issuing of paper receipts to voters. However, paper receipts have not been

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[4]California Attorney General Bill Lockyer claims Diebold Inc. defrauded the state by installing DRE systems what were neither tested or approved.

[5]Former VoteHere senior test engineer Daniel Spillane files a whistleblowers lawsuit in the Superior Court of the State of Washington in King County. The suit claims that VoteHere ignored hundreds of problems logged by Spillane regarding the companies DRE system. Spillane is also suing VoteHere for wrongful discharge.

allowed since they violate the voter's right to anonymity[6] [6]. Fortunately, several methods have been proposed that would allow for a voter-verifiable paper audit trail[7] [4, 6].

One such audit trail, proposed by David Chaum, uses a mathematically proven method of encryption to provide voters a printed receipt of their choices while inside the voting both but provide no information once they leave. Chaum also demonstrates how this method would allow voters to verify that their ballots were included in the final results by comparing their receipt to those published on the Federal Election Commission's website [6]. As a result, any voter can independently verify that their ballot is correct and can have assurance that their ballot is accurately reflected in the final election results.

I intend to use a combination of David Chaum's receipts, other available technologies, and my own original research and ideas to present an idealized model of a DRE voting system. This idealized DRE system will provide the basis for a discussion of the trade-offs inherent in the switch from traditional to digital voting systems. This switch is almost inevitable in our technology-driven society, and so the pros-and-cons of any system must be examined in order to define criteria for any "real-world" DRE system.

2 Procedure

The number of resources relating to DRE systems has grown dramatically as a result of the 2000 presidential elections and subsequent state and local elections. As a result, finding resources was not a difficult process, but a large portion seem to be overly opinionated as opposed to scientifically objective. However, many professional societies such as The Institute of Electrical and Electronic Engineers (IEEE) have entire issues of their magazines dedicated to the issues and science of DRE systems.

2.1 Research completed

While my prior interest into DRE systems provided a good social and contextual study, I required technical knowledge relating to current DRE systems and proposals. As a starting point for my research, I searched for "electronic voting systems" in all fields of the **INSPEC** database. I decided to restrict the search to articles published between 1990-2004. Sifting through the 273 records, I eliminated articles that focused on topics outside the scope of this proposal. After reading abstracts and full-text introductions, I determined that the most relevant articles were [1, 4, 5, 6].

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[6]Paper receipts also facilitate vote selling which is a major issue during close elections.
[7]California now requires by law that DRE systems produce a voter-verifiable paper audit trail[4]

A newsbrief on National Public Radio (NPR) first brought to my attention that the State of California sued Diebold for issues relating to the gubernatorial recall election. In response, I performed a **Google News** search for "California lawsuit against Diebold" (169 results as of 19:00 on Tuesday, September 14th, 2004). Most of the results were links to small-town newspapers, and most provided limited coverage.

In response, I performed a search on **CNN** using the same key-phrase. Of the two results (as of 19:00 on Tuesday, September 14th, 2004) the most applicable to the events discussed on NPR was [7] which outlined the state's case and motivation.

Discussions with Cornell Computer Science major Greg Roth '05 provided a link to another, slightly older, article [2] that provided an in-depth look at the analysis of the Diebold's AccuVote-TS source code. This analysis provided a detailed description of what improvements need to be addressed before DRE systems could be viable largescale.

2.2   Research agenda

Since the focus of the proposed research is to develop a concept for a viable DRE system, further research must be done to identify common failures of current DRE systems and investigate new approaches to solving them. A general summary of necessary research includes:

1. **Study traditional voting systems.** Numerous voting systems are in use in the United States, and each have their benefits and shortcomings. Studying and understanding these systems would identify properties DRE systems should exhibit as well as those that should not.

2. **Understanding the perspective of voters.** Voter trust is essential to the success of DRE systems in future elections.

3. **Investigating proposed voter-verified paper audit trail schemes.** Several schemes exist and each have their advantages and disadvantages. Striking a balance between security and feasibility is crucial.

3   Qualifications

As a senior Electrical and Computer Engineering major and Computer Science minor with a focus in system security both from a hardware and software perspective, my expertise lends itself to this project. In addition, as a summer intern at IBM Burlington (Vermont), I was exposed to real world engineering. Although not security related, the experience exposed me to the various real world problems encountered when creating a robust system. Since the

2000 presidential election, I have been developing and proposing new methods for election reform. As a junior in high school I had a chance to discuss my ideas with my state's congressman, Bernie Sanders (I-Vermont). I have done many revisions of my voting system as new developments and ideas have arisen, and I already have a DRE (or pseudo-DRE) system design in the works. Through further research and consultation with experts, it should not be a difficult task to adapt my work-in-progress into a DRE system model for the purposes of this project.

References

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