Ballot Definition Files

No Review Is Provided
for a Key Component of Voting System Software

www.VotersUnite.Org/info/BallotProgramming.pdf

Overview

Every electronic system — whether optical scan or DRE (Direct Record Electronic) — includes a key custom component that undergoes minimal testing and no independent audit. This custom component is directly responsible for recording and tallying votes and for determining the outcome of the election. Therefore, it is most important that this component be fully audited and error-free.

This component is the election definition data, also called "ballot data."

Ballot definition data is constructed for each specific election and contains all the details about that election. The DRE or optical scanner uses the ballot data to determine how selections on the screen or ballot are recorded in the vote database, which contains the results. The tally software uses the ballot data as a "key" when it interprets the content of the vote database and calculates the final tallies. Without the ballot data, the system cannot function. With incorrect ballot data, the system functions incorrectly.

Accurate election results require accurate ballot definition data. Some counties have hundreds of ballot styles, and each one must be programmed correctly since human error at this point could be magnified by the number of voters. The process of creating the ballot definition data is so complex that many counties **contract the work to voting machine vendors or other programmers**, who then write the ballot data to chips, data packs, or memory cards used by the machines.

The voting system standards developed by the Federal Election Commission and the National Association of State Election Directors require all voting system software to be passed through a source-code audit unless it is unmodified commercial off-the-shelf software. While the ballot definition may be primarily data, it could contain a program that would affect the results, yet it is not passed through any independent audit. This critical component is not subject to any certification other than whatever Logic and Accuracy (L&A) testing a jurisdiction chooses to do. Some L&A tests are performed in a different operating mode than actual elections; in those cases the ballot data is **never** subjected to a true field test before the election.

Some jurisdictions test optical scanners with test ballots created by the same vendor that created the ballot data; thus they release significant control of the election to the vendor. Other officials create their own test ballots or use a test deck from the vendor supplemented with their own test ballots. Some jurisdictions with DREs use the simulation program supplied by the vendor to "test" the election data. Some simply make sure that each button on the screen works correctly. Some do even less.

Since the only verification performed on ballot data is the completely inadequate L&A testing, it is not surprising that many election errors have been caused by flawed ballot data. For example:

♦   67,000 absentee and early-voting ballots were counted incorrectly. (New Mexico, Nov. 2000)
♦   A difference in ballot data on different machines resulted in miscounts in 18 races. (Texas, April 2002)
♦   2,642 Democratic and Republican votes were counted as Republican. (Florida, Sept. 2002)
♦   Victories for two commissioners were initially given to the wrong candidates. (Texas, Nov. 2002)
♦   5,500 party-line votes, both Republican and Democrat, were uncounted. (North Carolina, Nov. 2002)
♦   Loss reported for a candidate for County Board of Supervisors was really a win. (Iowa, June 2006.)

These errors were detected by alert election officials and poll workers who noticed irregularities in the results. The inaccuracy of the results was determined by hand-counting the paper ballots. However, not all ballot data errors would be noticeable. Votes on either DRE or optical scan ballots could be counted for the wrong candidate or not counted at all without raising any red flags.

It is significant that when irregularities occur on optical scan systems, election officials check the paper ballots to see if there is reason to suspect a problem with the tally. When similar irregularities occur on paperless DRE systems, there is wide speculation about the cause of the irregularity, yet, almost invariably, election officials assume that the results are correct. **There is nothing else they can do.**

When ballot data errors are detected, the person who programmed the data — often the vendor — simply calls it a programming error. Often, after the error is corrected, the patched data is loaded, and the machines use the new, untested, un-audited ballot data to re-tabulate the votes. Normally, the re-tabulation is simply accepted as correct. Since no testing is done on the replacement software, it could contain a more subtle error that might not be detected. If an error, intentional or accidental, went undetected, the election outcome could easily be both incorrect and uncontested.

It is unreasonable to believe that these scenarios have not occurred. It is unreasonable to believe that they will not occur in the future — on both DREs and optical scan machines — and impact elections in ways that are undetected. With so many documented cases of ballot data errors on optical scan machines, it is unreasonable to believe they have not occurred on DREs, yet none have been reported as such. This is not surprising, since only recounting paper ballots or auditing the ballot data would detect a ballot data error.

In response to the warnings of computer experts, many election officials have claimed that their security procedures guard against vulnerabilities. However, security procedures do not guard against the possibility of flawed ballot definition data. Furthermore, since the software underlying the ballot data is a trade secret of the vendor, there is no way for election officials to know precisely how the ballot data is being used. While testing may reveal errors, testing can never ensure that software is error-free.

The more that software is used in the administration of an election, the more the election administrator is handing control of the election to computer programmers. If the programmers are not supervised by the election director, neither are the software processes the programmer controls.

Personnel Who Control Election Processes

Paper Ballots		Optical Scan System		DRE System	
Election Supervisors	**Computer Programmers**	**Election Supervisors**	**Computer Programmers**	**Election Supervisors**	**Computer Programmers**
Design Ballots			Design Ballots		Design Ballots
Provide Correct Ballot to Voter		Provide Correct Ballot to Voter			Provide Correct Ballot to Voter
Collect Ballots		Collect Ballots			Collect Ballots
Count Ballots			Count Ballots		Count Ballots
Tabulate Outcomes			Tabulate Outcomes		Tabulate Outcomes
Preserve Ballots		Preserve Ballots			Preserve Ballots
			Operate Computer	Operate Computer	

Reference Details

The Ballot Definition Data

Every election conducted on any DRE or optical scan machine requires an election-specific ballot definition file. According to the Compuware Report,[1] an analysis of the four major DRE vendors, the ballot definition data includes:

♦   Precincts
♦   Races and their relationships to precincts
♦   Candidates and their relationships to races

The Johns Hopkins/Rice Report[2] describes the ballot definition data this way:

> The data "contains everything from the background color of the screen and information about the candidates and issues on the ballot to the PPP username and password to use when reporting the results." [3]

When Sam Reed, Washington Secretary of State, certified the Diebold AccuVote TS for use in Washington State, his certification statement pointed out how comprehensive the ballot data is: [4]

> "In preparation for ballot counting, the user enters (or downloads from a compatible voter registration system) office descriptions, positions, precinct combinations, ballot types, and any statistical information such as registered voter totals. The GEMS software is also used to produce and download the election definition including the precinct specific programming for the entire county onto the PCMCIA card."

How The Ballot Files are Created and Distributed

According to the Compuware Report, the ballot definition files for each DRE system are created in the management program and loaded into the voting machines on either PEB cartridges (ES&S) or PCMCIA cards. The ballot definition data is loaded onto all DREs, as well as the machine that performs the final tally.

Ballot definitions are loaded onto optical scanners through a variety of media. For example:

♦   ES&S Model 150 and 650 central-count optical scan systems — a chip containing the ballot definition is physically installed on a board inside the machine.

♦   Optech 4C central-count optical scan — a floppy disk is inserted into the PC that controls the scanner.

♦   ES&S Model 100 precinct-count optical scan — a memory card is inserted into the machine.

♦   Optech 3P Eagle precinct-count optical scan — a memory pack is inserted into the machine.

♦   Diebold AccuVote OS optical scan — a memory card is inserted into the machine.

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[1] Direct Recording Electronic (DRE) Technical Security Assessment Report. Prepared for the Ohio Secretary of State by Compuware Corporation; http://www.sos.state.oh.us/sos/hava/files/compuware.pdf

[2] Analysis of an Electronic Voting System. By Tadayoshi Kohno, Adam Stubblefield, Aviel D. Rubin, and Dan S. Wallach; February 27, 2004.(first released July 23, 2003)

[3] Analysis of an Electronic Voting System. page 13

[4] Report Of The Secretary Of State On The Examination And Evaluation Of An Direct Recording Electronic Vote Tallying System., page 1. September, 2002. http://www.secstate.wa.gov/elections/pdf/diebold_votingsystem.pdf.

How the Ballot Files are Used by the System

On a DRE, the content of this file determines the ballot that is displayed on the screen for each voter; it also determines how the completed vote is recorded in the vote database. On an optical scan machine, this file guides the processes of reading the scanned ballots, interpreting the marks on each ballot according to their locations on the ballot, and determining how to record the interpretation of those marks in the vote database. The tally software in both types of systems uses the ballot definition data as a "key" when it interprets the content of the vote database and calculates the final tallies.

The Johns Hopkins/Rice Report emphasizes that the reliability of the election results depends on the accuracy of the ballot data. The report tells us:

♦ "[M]any of the fields inside are easy to identify and change, including the candidates' names, which appear as plain ASCII text." [5]

♦ Adding, removing, or changing issues in the file could modify the ballot and thereby confuse the result of an election. [6]

♦ "By simply changing the order of the candidates as they appear in the ballot definition, the results file will change accordingly. However, the candidate information itself is not stored in the results file, which merely tracks that candidate 1 got so many votes and candidate 2 got so many other votes. If an attacker reordered the candidates on the ballot definition, voters would unwittingly cast their ballots for the wrong candidate." [7]
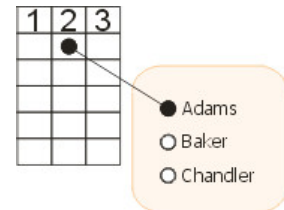
   The RABA report, based on actual use of the machine, confirmed the Johns Hopkins/Rice conclusion: "the team was able to demonstrate the ability to switch two candidates and still successfully load the election and ballot. Consequently, the voter appeared to vote for the candidate of his choice but he actually voted for another candidate... In this fashion a voter can be deceived into thinking he is voting for one candidate when, in fact, the software is recording the vote for another candidate."[8]

It is significant that the processing in each system can be affected by the content of the ballot data and that the ballot data can be used in different ways, depending on supervisor functions. For example:

♦ The Johns Hopkins/Rice Report points out that processing on the DRE can differ according to the party affiliation of the voter or the candidate. If the party affiliations of the candidates were changed, voters might be forced to view and vote on erroneous ballots. [9]

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[5] Analysis of an Electronic Voting System. page 13

[6] Analysis of an Electronic Voting System. page 13

[7] Analysis of an Electronic Voting System. page 13

[8] Trusted Agent Report: Diebold AccuVote-TS Voting System, page 18. January 20, 2004. Prepared by: RABA Innovative Solution Cell (RiSC), Dr. Michael A. Wertheimer, Director.
   http://www.raba.com/press/TA_Report_AccuVote.pdf

[9] Analysis of an Electronic Voting System. page 13: "In the system, different voters can be presented with different ballots depending on their party affiliations (see CBallotRelSet::Open(), which adds different issues to the ballot depending on the voter's m_VGroup1 and m_VGroup2 CVoterInfo fields)."

♦   Secretary Reed's statement also points out that there is logic in the DRE that changes the way the
    ballot data is used, depending on the operating mode of the system. He says:[10]

    "The AccuVote AVTS-R6 can be then be initialized as an 'early voting' system with access to all
    the precincts and ballot styles for an election when any programmed PCMCIA card is installed.
    Alternatively, the AccuVote AVTS-R6 can be initialized for a specific polling place with a
    specified subset of precincts and ballot styles at the time the PCMCIA card is installed."

♦   Further, the RABA report points out that in the Diebold system the software contains logic for
    processing "weighted ballots" — a feature which they say is unnecessary in Maryland and which they
    suggest is unnecessary in any general election. They suggest removing this logic. [11]

The Ballot Definition File is an Unaudited System Component

The ballot definition data is a crucial component of the recording/tallying process. Alterations in the
ballot data affect the recording and tallying of votes, and commands given to the system software impact
the way the ballot data is used. This means that the ballot definition data is as critical to the operation of
the system as the underlying software. In fact, in the Compuware Report, encrypting the ballot data was
considered to be as important as encrypting the vote data.

In its list of serious concerns about hacking, the RABA team placed ballot definitions on a par with
software and vote data. The report states:

> Given physical access to the server, one can insert a CD that will automatically upload malicious
> software, modify or delete elections, or reorder ballot definitions.[12]

Since the design of each system is a trade secret of the vendor, there is no way of knowing what
processing logic might be executed on the ballot definition data or the ways in which that processing
logic is impacted by the content of the ballot file.

Doug Jones, professor of computer science at the University of Iowa and a member of the Iowa Board of
Examiners for Voting Machines and Electronic Voting Equipment, says: "The FEC/NASED Voting
System Standards require that all software used in voting systems be passed through a source-code
audit" unless the software is unmodified commercial off-the-shelf software. [13]

However, **even though ballot definition files could contain programs,** they are not passed through an
independent audit. They are not subject to any certification other than whatever L&A testing that
jurisdictions choose to do. Some jurisdictions do very little, and many serious election problems have
been caused by flawed ballot definition files that have **passed** L&A testing.

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[10] Report Of The Secretary Of State On The Examination And Evaluation Of An Direct Recording Electronic Vote
Tallying System., page 1. September, 2002. http://www.secstate.wa.gov/elections/pdf/diebold_votingsystem.pdf.

[11] Trusted Agent Report: Diebold AccuVote-TS Voting System, page 24.

[12] Trusted Agent Report: Diebold AccuVote-TS Voting System, page 20.

[13] http://www.cs.uiowa.edu/~jones/voting/dieboldftp.html

Flawed Ballot Definition Files on Optical Scanners and Punch Card Machines

While the cause of many election miscounts is not clear, many other miscounts suggest that the ballot definitions were programmed incorrectly. Here are several examples of elections in which errors in the ballot definition file **definitely** caused the problems:

November 2000. Bernalillo County, New Mexico. A flawed ballot definition file for the presidential election caused 67,000 absentee and early-voting ballots to be counted incorrectly by the Diebold AccuVote OS optical scan machine. The ballot programmer had neglected to link the candidates' names to their respective parties.[14]

September 2002. Union County, Florida. A programming error caused ES&S Model 100 machines to read 2,642 Democratic and Republican votes as entirely Republican in the September 2002 election. The ballot program in the memory packs read the ballots incorrectly. The vendor, ES&S, accepted responsibility for the programming error and paid for a hand recount. [15]

September 2002. Robeson County, North Carolina. Ballot tabulating machines failed to work properly in 31 of 41 precincts. Local election officials said the problem was the result of a software glitch, and ballots had to be recounted. There had been a problem in the programming of the memory cards. [16]

November 2002. York County, South Carolina. An error in the ballot definition file for the punch card machines caused votes for the South Carolina Commissioner of Agriculture to be uncounted. The punch number for the straight ticket had been set up incorrectly. Changing the program to recognize the correct number allowed the machine to count the ballots correctly. [17]

November 2002. Scurry County, Texas. A landslide victory for two commissioner candidates caused poll workers to question the results. The chip in the ES&S 650 contained an incorrect ballot program. ES&S sent a new chip, and the county officials also counted the votes by hand. The opposing candidates actually won by large margins.[18]

November 2002, Taos, New Mexico. A software programming error caused the Sequoia Optech optical scanner to assign votes to the wrong candidates. Just 25 votes separated the candidates in one race; another race had a 79-vote margin. After noticing that the computer was counting votes under the wrong names, Taos County Clerk Jeannette Rael contacted the programmer of the optical machine and was told it was a programming error.[19]

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[14] "Human error is cause of N.M. election glitch." Government Computer News; November 20, 2000; Vol. 19 No. 33 http://www.gcn.com/vol19_no33/news/3307-1.html

[15] 6/2/04 Conversation with Barbara Montpetit, Supervisor of Elections. Original reference was from *Black Box Voting,* Chapter 2. "Sometimes the old ways are best." The Bradenton Herald, 17 September 2002.

[16] January 2004 Conversation with Dinah in the Robeson County Clerk's office. Original reference was "Voter turnout surprises officials." Sun News. September 12, 2002. http://www.myrtlebeachonline.com/mld/sunnews/news/local/4056664.htm

[17] 06/04/04 Conversation with Wanda Hemphill, York County Elections Director. Original reference was from *Black Box Voting*, Chapter 2. The Herald, Rock Hill, SC , 7 November 2002; "Machine glitch keeps votes from being counted"

[18] 06/03/04. Conversation with Scurry County Elections Director, who told me it was an ES&S 650. She said it was the chip with the ballot programming on it, that they had to get a new one from ES&S. Original reference was from *Black Box Voting,* Chapter 2. Houston Chronicle, 8 November 2002; "Ballot glitches reverse two election results"

[19] 06/03/04. Conversation with a woman at the Elections Division of New Mexico. She told me Taos used the Sequoia Optech and confirmed that it was a programming error by the local programmer. New Mexico does not have their ballot programming done by the vendor. Original reference from *Black Box Voting,* Chapter 2. Albuquerque Journal, 7 November 2002; "Taos To Recount Absentee Ballots"

November 2002, Wayne County, North Carolina. A programming error caused the Optech Eagle optical scan machines to skip several thousand party-line votes, both Republican and Democrat. Correcting the error turned up 5,500 more votes and reversed the outcome for the House District 11 state representative race.[20]

April 2003, Lake County, Illinois. An ES&S ballot programming error failed to account for "no candidate" listings in some races on the ballot, and results were placed next to the names of the wrong candidates in four races. Correcting the problem changed the outcomes in some races.[21]

May 2004, Craighead County, Arkansas. The chip programmed by ES&S for the county's optical scanner gave one candidate all the votes for constable. A manual recount revealed the error. [22]

November 2004, Medford, Wisconsin. ES&S programmers failed to set up the optical scanners to read straight-party votes. About 600 of the 2,256 ballots cast were not counted.[23]

June 2006, Pottawattamie County, Iowa. ES&S set up the ballot data and created the test deck, but failed to account for candidate rotation, so votes were tallied wrong in the rotated races.[24]

The following miscount strongly suggests that the candidates were simply switched in the ballot data of the computer in "one ward."

August 2002. Clay County, Kansas. The tabulation machine showed that one candidate for commissioner had won, but a hand recount showed that his opponent had won by a landslide. **In one ward, the computer had mistakenly reversed the totals.**[25]

Though the cause of the following problem wasn't fully analyzed, the symptoms suggest that the ballot definition file in the central tabulation computer didn't match those on the data packs.

November 2002. Baldwin County, Alabama. The ES&S Optech 3P Eagle optical scanners printed out results of the gubernatorial election when the polls closed. Then the data packs were taken to the central computer to be tabulated, and the tabulation machine, which gave different results, showed the election was won by the wrong candidate. Three other counties had the same problem, but they corrected the problem by typing in the vote totals rather than reading the data packs.[26]

In each of the following cases, the vendors attributed the problems to the tally computer's inability to handle the data. However, the symptoms could also indicate the possibility of errors in the ballot definition file on the tally computer.

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[20] "Winners' may be losers." The News and Observer; November 12, 2002; By Wade Rawlins and Rob Christensen. Reproduced at: http://66.102.7.104/search?q=cache:iy0f4rgd7oMJ:www.ncdot.org/news/dailyclips/2002-11-12zz.html+%22%27Winners%27+may+be+losers%22+wayne&hl=en

[21] "Returns are in: Software goofed — Lake County tally misled 15 hopefuls." (reproduced) Chicago Tribune; April 4, 2003; By Susan Kuczka, Tribune staff reporter. http://www.truevotemd.org/doc_lake_county.asp

[22] "Commission OKs results of elections." Jonesboro Sun, May 28, 2004. By LeAnn Askins. http://www.jonesborosun.com/archivedstory.asp?ID=9486

[23] "About 600 Medford ballots cast in November ignored." Marshfield News-Herald. March 12, 2004. By Jake Rigdon. http://www.wisinfo.com/newsherald/mnhlocal/285285292773470.shtml

[24] Faulty voting machines delay results; counting under way. The Daily Nonpareil Online. June 7, 2006. by Tim Rohwer. http://www.zwire.com/site/news.cfm?newsid=16751509&BRD=2703&PAG=461&dept_id=555106&rfi=6

[25] "Aug. 6 ballot problems alleged: Clay, Barton county candidates seek review of races." Lawrence Journal-World. August 22, 2002. The Associated Press. http://www.ljworld.com/section/election02/story/103526

[26] "Voting snafu answers elusive" The Mobile Register; 28 Jan 2003; by Brendan Kirby, staff writer; November 2002. Reproduced at http://www.votewatch.us/forum/showthread.php?t=46. 06-02-04. Conversation with Sharon Jerkins in the Baldwin County Elections office, who gave me the model number of the optical scan machines.

March 2004. San Diego, California. Diebold AccuVote OS optical scan machines counted 208,446 ballots. The machines miscounted 2,821 votes in the Democratic presidential race and the Republican U.S. Senate seat. [27]

Most of the absentee miscounts occurred in the Democratic presidential race, in which 2,747 votes cast for John Kerry were incorrectly credited to Rep. Dick Gephardt. In the Senate race, in which Bill Jones won, 68 votes cast for Barry L. Hatch were credited to candidate Tim Stoen, and six votes cast for James Stewart were credited to Stoen. [28]

June 2004. Colfax, Curry, and Dona Ana Counties, New Mexico. Sequoia Optech Insight precinct-count optical scanners produced inaccurate tallies. The super-precinct feature, which totals the votes by Legislative district, didn't work. County officials also noticed that, when the super-precinct feature was used, the machine's protective counter, which records all votes cast, wasn't incrementing properly on four out of five machines tested. [29]

Note: The last paragraph of the article indicates that the L&A testing failed as well: "Dona Ana County District Attorney Susana Martinez, who ran unopposed in the primary, said she wouldn't challenge the primary results. But she objected to using the Insight machines in early voting after they produced faulty numbers in their public certification, she said. "

Why were the flawed machines used for the election? Because the county has no procedures for dealing with a failed L&A test.[30]

Flawed Ballot Definition Files on DREs

Here is one case when flawed ballot data on a DRE caused a serious election miscount. It was detected **only** because voters had also used optical scan paper ballots in the election.

April 2002. Dallas, Texas. A candidate for Rowlett mayor was added to the ballot four days before the start of early voting. The change in the ballot definition wasn't programmed into all 390 ES&S iVotronic machines until after early voting began. When the results were combined with the results from ES&S optical scan machines, the error caused the tally software to improperly tally results in the mayor's race as well as 17 other races, including propositions and school board races. Nearly 5,000 of the 18,000 ballots were improperly counted.[31]

Since so many optical scan ballot data files have been flawed, it is only reasonable to believe that there have been many flawed ballot files used in DRE elections as well. However, on a DRE, miscounts caused by an error in the ballot definition data would go unnoticed. Votes for one candidate could be handed to the other candidate, and there would be no way to know that it happened. There would be no way to recover if a programming flaw were suspected.

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[27] "New electronic scanners miscounted some county votes." NC Times April 7, 2004; By: Gig Conaughton - Staff Writer; http://www.nctimes.com/articles/2004/04/08/news/top_stories/22_27_394_7_04.txt

[28] "Some votes miscounted in primary, officials say." Union-Tribune. April 8, 2004. By Luis Monteagudo Jr. and Helen Gao, staff writers. http://www.signonsandiego.com/news/politics/20040408-9999-1m8vote.html

[29] "Company denies problem with voting program." Clovis News Journal; June 3, 2004; By Jack King: CNJ Staff Writer; http://cnjonline.com/engine.pl?station=clovis&template=storyfull.html&id=6358

[30] 06/21/04 Interview with Susana Martinez.

[31] "Glitch affects 18 races   Problems in counting early votes could alter some election outcomes." Dallas Morning News. May 8, 2002. Ed Housewright, staff writer.

The process of detecting the source of elections problems is more difficult for DREs than for optical scanners because all the operations on a DRE are run by software. With optical scan equipment, elements in the process are distinct and therefore problems are more easily isolated. For example, the paper provides information about whether the problem occurred in the recording process (by the voter), the counting process (by the machine), or the tally process (by the tally machine).

With DREs, the processes are all hidden inside the machine and an observer cannot distinguish which process contains the flaw. So, when an observer notices an error and does not have access to the source code or even the software design, it is difficult, if not impossible, to determine whether 1) the voter used the machine incorrectly, 2) the vote was not accepted by the machine, 3) the vote was recorded incorrectly, or 4) the vote was tabulated incorrectly.

The fact that all the election processes involve software also makes it virtually impossible to detect ballot errors on a DRE without examining the ballot data. Optical scan errors have been detected only when the election officials noticed discrepancies between the results and the paper ballots or other paper records.

Nevertheless, some DRE problems do indicate the presence of flawed ballot programs. Since the design of the software is secret, the functions of each module and the interaction between them can only be deduced from the information presented in news articles and the information in analysis reports, such as those from Compuware and the Johns Hopkins/Rice team. Using that information, along what we know about the ballot programming errors on optical scan equipment, it is reasonable to deduce that the following are examples of ballot definition flaws in DRE systems.

April 2003. Palm Beach County, Florida. Sequoia AVC Edge. Former Boca Raton Emil Danciu was ahead by 17 points in a poll conducted by the opposition. Exit polling indicated an overwhelming win for Danciu, but he received only 19% of the votes, even losing in his home precinct. Voters report that their votes appeared to be registered for his opponent.

"They repeatedly tried to vote for him [Emil Danciu], but another name, particularly Haynie's [the candidate with the highest total], came up. They couldn't get their vote registered. They were telling wild stories about poll workers unplugging and kicking the machines. They didn't know whether their votes ever counted. Some were told to vote again." [32]

Deduction from the available evidence suggests a flawed ballot program on the DREs may have perverted the election results. Reasons:

♦   The discussion of the ballot definition file in the Johns Hopkins/Rice Report [33] indicates that the ballot data determines both the display on the screen and the interaction of the user's actions with that display. Therefore, since many voters said their votes for Danciu were displayed as votes for Haynie, it is clear that the ballot definition file was flawed in some way.

♦   Since the flawed ballot definition data displayed Danciu's votes as votes for Haynie, logic suggests that votes for Danciu may have also been **recorded** as votes for Haynie, particularly considering the wide discrepancy between the pre-election poll and the election totals.

November 2002. Broward County, Florida. The original tally of the ballots cast on ES&S iVotronic DREs missed 103,000 votes. The software error was found and the votes were recounted, revising voter turnout from 35% to 45%.[34]

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[32] "Out of Touch: You press the screen. The machine tells you that your vote has been counted. But how can you be sure?" New Times; April 24, 2003; By Wyatt Olson; http://www.newtimesbpb.com/issues/2003-04-24/feature.html/1/index.html

[33] Analysis of an Electronic Voting System. page 13

[34] "Election glitch missed 103,000 votes in Florida county; Ballots caught, counted early next day" CNN; November 8, 2002; http://www.cnn.com/2002/ALLPOLITICS/11/07/elec02.florida.votes.missing/

The symptoms suggest that the ballot program on the DREs was different from the ballot program on the tally machine. It is likely that correcting the software error involved correcting the ballot data on the tally machine. Reasons:

♦ The flaw must **not** have been on the DREs, or there would have been no way to retrieve the uncounted votes.

♦ It is unlikely that the problem was corrected by altering the underlying software in the tally program, since that would mean the same type of problem would have occurred in other counties using the ES&S tally software.

November 2003. Fairfax County, Virginia. The new Advanced Voting Systems WINVote touch screen machines malfunctioned in a variety of ways. One of the problems was that voters had difficulty getting their votes for Rita Thompson, a school board candidate, to stay lit on the screen. Later testing on one machine showed that it was subtracting about one of a hundred votes for Ms. Thompson.[35]

Since the problem occurred both on the screen and in the vote data, it may indicate a ballot programming error. One of the voters who had difficulty suggested this explanation in a letter to Ms. Thompson (highlighting added):

When I got to the part on page 2 for School Board candidates, I touched x's against candidates Hunt and Hurley, and then touched your name to place the third *x*.

Before moving on to the third page, I scanned all my votes on the screen and noticed that the highlighting and x was now missing from your name. So I touched the selection key by your name again, but after a second or so the x and highlighting again disappeared. This happened four or five more times before the highlighting and *x* finally stuck, and on the review page I ensured that your name was included before hitting the Vote key.

I reported this irregularity to the assistant voting official, and she said she would test out your key on the touch-screen after I left. However, it later occurred to me that if this problem was not the result of a malfunctioning key, **it might be due instead to a machine that was not properly programmed to accept three names under a particular category;** or to some other reason. [36]

In the same election, one witness reported that "uncontested candidate buttons didn't work." Another reported that one machine "would not take (State Senate Candidate Chris) Braunlich [and] kept changing the vote to (Toddy) Puller."[37] Both these problems also suggest the possibility of a flawed ballot definition file, though since we don't know of any related miscounts in the vote data, they might also suggest a flawed touch screen.

May 2006. Arkansas. After "reviewing the programming code" from ES&S and discovering errors, **eight** counties in Arkansas decided not to use their ES&S iVotronics touch screens in the primary.[38] Since officials are not allowed to review the actual programming code (which is a trade secret), this report suggests that the ballot data was reviewed and found to be defective.

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[35] Operation Ballot Integrity. A Report by Fairfax County Republican Committee. Page 21.
   http://www.fairfaxco-gop.org/download/ballot_integrity.pdf

[36] Operation Ballot Integrity. Page 18.

[37] Operation Ballot Integrity. Page 18.

[38] Election Problems Persist For Eight Counties. Today's THV. June 8, 2006.
   http://www.todaysthv.com/news/news.aspx?storyid=29699. & Eight counties won't use electronic equipment in runoff. The Log Cabin Democrat. June 9, 2006. by Andrew DeMillo, Associated Press Writer.
   http://ap.thecabin.net/pstories/state/ar/20060609/4000271.shtml

Programming and Testing the Ballot Definitions

Because the ballot definition files are an integral part of the functioning software, and because no independent audit is performed on them, the thoroughness of the testing is crucial. The agency that generates the ballot data and the testing that is performed varies by jurisdiction. Telephone interviews with county officials provided the following information, which gives a sampling of the ways in which ballot data is generated and L&A testing is done in U.S. jurisdictions.

The data in this table was collected as of June 2004 and some may be outdated. Since then, even more jurisdictions have contracted with vendors to supply the ballot definition data for their elections. The 2006 primaries show an abundance of errors in the ballot definition files provided by vendors.[39]

Jurisdiction	St	Ballot Programming	L&A Testing
All counties	OK	ES&S Model 100. Counties do everything. The vendor is not involved in any way. They even wrote their own software that creates the ballot definition files.	Test deck created by the counties.
Wake County	NC	ES&S Optech 3P Eagle precinct-count optical scan. County IT personnel do everything: maintain the equipment and program the ballots.	Test deck created by the county.
Jefferson County	WA	ES&S Optech 4C central-count optical scan. County elections supervisor programs the ballots. Very difficult, but she has been doing it for 12 years.	Test deck created by the county. Ballots are printed by a local printer.
Snohomish County	WA	Sequoia AVC Edge touch screen. County programs the ballots. Very difficult, but they do not want to have the vendor do it.	Testing ensures that every button on the machine works.
Volusia County	FL	Diebold AccuVote OS precinct-count. County technicians program the ballots.	Test deck created by the county.
All counties	NM	Diebold, Sequoia Counties do all their own ballot programming.	
All counties	MD	Diebold Accuvote TS touch screen. The state BOE now hires a contractor who creates the ballot definitions. This is the first time the counties have not created their own ballots.	
Palm Beach County	FL	Sequoia AVC Edge. **County programs the ballots.**	Automatic simulator is run on each machine. Then a single ballot is cast on it.
Union County	FL	ES&S Model 100 optical scan. **ES&S programs the ballots** and sends the memory packs to the county officials. The county has no way of programming the definitions. Registrar says they have never had problems with the machines, only with the memory packs.	Test deck from ES&S

[39] See "Vote-Switching Software Provided by Vendors:" http://www.votersunite.org/info/mapVoteSwitch.pdf and http://www.votersunite.org/info/Vote-Switchinginthenews.pdf

Jurisdiction	St	Ballot Programming	L&A Testing
Baldwin County	AL	ES&S Optech 3P Eagle optical scan. **ES&S programs the ballots** and sends the county the memory packs and test decks. The county has no way of creating their own memory packs.	Two tests with test decks from ES&S. Judge tests first with additional ballots. Then there is a public process and the public may add ballots.
Scott County	IA	ES&S Optech 3P Eagle optical scan. **ES&S programs the ballots** and sends the county the memory packs and test decks. The process of creating their own memory packs is too difficult. ES&S Optech 4C Central-count optical scan. ES&S sends a floppy containing the ballot program. Ballot programming is done on a DOS-based program, which is too difficult.	Test deck from ES&S
All counties	MT	ES&S Model 100, 150, 550, and 650. **ES&S programs the ballots** and prepares the data packs for the 100, and it prepares the chips for the 150, 550, and 650. It also sends test decks. The counties have no way of preparing the ballot definitions themselves.	Test deck from ES&S with the county's own test ballots added.
Scurry County	TX	ES&S Model 650 central-count optical scan. **ES&S programs the ballots** and sends the chip to the county.	
Sevier County	AR	ES&S Model 150 central-count optical scan. **ES&S programs the ballots** and sends the chip to the county.	
Marion County	WV	ES&S 150, 650, and iVotronic (early-voting). **ES&S programs the ballots** and sends the chips and memory cards, along with test decks for the optical scanners.	Test deck from ES&S
Clay County	KS	ES&S central count. ES&S programs the ballots	Test deck the county creates
Appling County (other counties)	GA	Diebold AccuVote TS (OS for absentee) County technicians do all the ballot programming. **Some counties have Diebold program the ballots.**	
Jefferson County	CO	ES&S iVotronic. **ES&S programs the ballots.**	
York County, (other counties)	SC	Punch card. Local programmer does the ballot definitions. Error in 2002 election was because one of the punch numbers was defined wrong. **Many counties have vendors do their ballot programming.**	Test deck the county creates

Conclusion

Errors have been detected in ballot definition files by alert election officials who noticed discrepancies between what they expected and what they saw in the results. But not all ballot programming errors would be noticeable. Votes could be switched and nobody would ever know. In the Clay County August 2002 election, the votes of two candidates **were** switched, and the error was discovered during the hand recount.[40] But if this occurred in an election in which no problems were noticed, a recount would be unlikely, and **a machine recount would show the same inaccurate result**. If the election were held on a DRE, a meaningful recount would be impossible.

Many ballot definition flaws have been noticed in optical scan elections (many more than are reported in this paper). Research for this paper found no instances of DRE ballot data errors revealed in the results of an election, except for the one that was detected because of the optical scan paper ballots used in the same election. It is unreasonable to believe that fewer of these errors have occurred on DREs than on optical scanners. It is only logical to believe that such errors simply have not been detected, especially since — unless the DRE provides an accurate voter-verified paper record of each vote — it is **impossible** to detect them without access to the system design or the ballot data itself.

Even when discrepancies are noticed, they are rarely investigated. The Georgia 2002 election has been the topic of wide speculation. The discrepancy between the polls and the results for Governor and U.S. Representative were noticed. But they could not be investigated because the voting machines were DREs. The outcomes may have been correct, but it is also possible that the ballot definition files were flawed. Compare this Georgia election with the November 2002 election in Scurry County, Texas, when a flawed chip in the ES&S 650 optical scanner gave landslide victories to two candidates for commissioner. Only a manual recount showed that their opponents won by large margins.

Even if discrepancies are investigated, they may not inspire the county to take remedial action. In the November 2003 election in Fairfax County, even though Rita Thompson lost by about 1% of the votes, and even though the machine that was tested subtracted 1% of her votes, the election was still certified with her as a losing candidate.

When elections are marred by "glitches," rarely is the source of the problem detected and explained to the public. Most news articles simply say that the problem did not affect the election outcome, and the vendor is looking into the error. Many of these "glitches" may be caused by flawed ballot definition files. It is difficult to understand why election officials don't hold the vendors accountable — why they don't demand a rigorous investigation into the source of each "glitch," followed by a public explanation of the problem and how it was corrected by the vendor.

The extreme complexity of election definition data, the astonishing lack of security procedures used to create them, the hopelessly inadequate testing, the impossibility of having a thorough independent review for every one of these election-specific components: these things make accurate electronic vote counting not just unlikely; they make it a fantasy.

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[40] "In one ward, which Mayo carried 242-78, the computer had mistakenly reversed the totals."
   Aug. 6 ballot problems alleged: Clay, Barton county candidates seek review of races. Lawrence Journal-World. August 22, 2002. The Associated Press. http://www.ljworld.com/section/election02/story/103526