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MEMORANDUM

TO: TACIR Commission Members

FROM: Harry A. Green
Executive Director

DATE: September 27, 2007

SUBJECT: Update on study of election issues

At the December TACIR meeting, Commissioners voted to undertake a study of the election system in Tennessee. The first update on that study was presented at the June Commission meeting and dealt with the way that Tennesseans vote. The primary issue was voting machines. Staff presented a list of potential improvements to the process. A copy is attached.

Since the last meeting, there have been several developments concerning voting technology in other states and nationally. Additional states have passed legislation requiring voter verified paper audit trails. An updated map of the requirements in other states is attached. There have also been interesting developments in two of our largest states, California and New York. Congress and the federal Election Assistance Commission have both considered changes in voting machine requirements, and a report by Dan Rather on touch screen machines raised new questions about their accuracy.

In addition, TACIR staff continues work on other election issues and will survey county election commissions about their experiences to inform the report.

California

California's Secretary of State, Debra Bowen, campaigned on the issue of reforming the state's electoral process. Upon taking office, she instituted a top-to-bottom review of the state's voting machines that began with decertification of all of the machines, to be followed by a full review of each and recertification if warranted. The state contracted with the University of California to conduct the reviews in four areas:

- documents and studies associated with each voting system
- source code in use for each voting system
- a “red team penetration attack” to see if the system can be compromised
- accessibility of the system for disabled voters

The cost of the top-to-bottom review is to be paid using some of California’s HAVA funds and by the voting machine vendors.

Security flaws were found in all of the voting systems in California. The “red team penetration attack” tests, essentially attempts by hackers to violate system security, found a way into every system.

According to the published results, California worked with four voting machine vendors prior to the review: Diebold (now Premier Election Solutions), Hart InterCivic, Sequoia, and ES&S. ES&S expressed reservations about the University of California reviewers, and it balked at providing its source code. The company finally agreed to do so only after Secretary Bowen formally requested a copy from the facility where it was held in escrow. In the end, Secretary Bowen declared that ES&S had not cooperated fully in a timely fashion and decided not to recertify the ES&S voting machines for future use in California.

The only Direct Recording Electronic (DRE) voting machine approved for future general use in California was the Hart InterCivic System 6.2.1. Some additional security measures were required, as well as extensive post-election audits, but the system was approved. Hart withdrew its system 6.1 from consideration and submitted the new system instead. Premier (formerly Diebold) and Sequoia DREs are to be used in a limited fashion, with just one machine per polling place for disabled voter access. They face strict security measures, including an assigned poll worker to monitor them constantly.

All of the optical scan voting machines submitted for review will be recertified with additional security and post-election audit requirements. A copy of the Frequently Asked Questions (FAQ) document from the California Secretary of State’s website is attached.

The California top-to-bottom review has been closely watched by officials in other states as well. The Secretaries of State in Colorado and Ohio have announced plans to conduct similar reviews in their states. Kentucky’s Attorney General, after a rather public argument with the Secretary of State, recently launched an investigation that found that the Premier (formerly Diebold) DREs in use in Jefferson County were not certified by the state. Though they had been certified in the past, the state had certified a newer version and the old ones had never been upgraded.

New York

New York has lagged the rest of the nation in updating its voting technology, with much of the state still using outdated lever machines. All states receiving HAVA funds were supposed to be in compliance with the provisions of the Act in time for the November 2006 election. New York has just missed the extended deadline it had been granted under a Consent Decree by the U.S. Department of Justice. It is unclear if there will be consequences for New York or if the state will receive another judicial reprieve, but it could face the loss of most or all of its HAVA funds.

New York had contracted two independent companies, CIBER and NYSTEC, to test voting machines. Previously, CIBER has approved machines in other states that were later decertified due to equipment and software defects and NYSTEC has been critical of CIBER's security test plan. Indeed, CIBER recently lost its accreditation from the federal Election Assistance Commission (EAC). CIBER did not inform the state election board of its EAC status; it was only brought to light after it was reported in a *New York Times* article. After censure from the state board, CIBER was suspended from any further New York testing in January 2007.

The state election board is currently inspecting machines but has not made any decisions, and the process continues to move slowly. As a result, some New York counties have opted to use uncertified machines in local elections. In May 2007, the City School Board of Troy used LibertyVote DREs for its elections, which are not certified for use in the state of New York. Liberty Election Systems offered the full-face touch screen machines to the city free of charge. The Troy School Board decided that state certification was not necessary for a strictly local election.

Despite lagging behind on machine updates, New York has passed legislation requiring independent security reviews of voting machine source code. In the case of compromised security, third-party escrowing allows for the underlying software codes used in voting machines to be inspected by an independent third party. Late in the state's 2007 legislative session, Microsoft lobbyists pressed for an amendment to weaken the third-party escrow clause and keep the underlying codes secret (many voting machine vendors use a Microsoft operating system, including Avante and Sequoia). The legislature did not pass the amendment and kept its strict election laws intact.

Congress

The U.S. House of Representatives' on-again-off-again interest in the election reform bill sponsored by Representative Rush Holt of New Jersey waned once more last week when the Rules Committee refused to recommend the bill for a floor vote. Citing opposition by state officials to the short timelines, inadequate

funding, and general usurpation of state authority over elections, members of the Committee voted to postpone consideration of the bill.

State officials are more comfortable with the bill introduced in the Senate by Senator Diane Feinstein of California. The bill has garnered support from several prominent Senators, but there has been no recent action on it, and it lacks a companion bill in the House.

The Election Assistance Commission (EAC)

In a sign that the move toward auditable paper records has reached a tipping point, the EAC, which was created by the Help America Vote Act, is completely revamping its "voluntary guidelines" for states for choosing voting machines. These guidelines are voluntary because states do not have to choose federally-certified voting machines, but only machines that meet the guidelines will be federally certified.

The EAC issued a press release on September 6th announcing that it had received a 598-page draft report from its Technical Guidelines Development Committee recommending that future guidelines

- allow auditing of voting system records independently from the voting system's software,
- allow each voter to verify the accuracy of their vote before leaving the polling station,
- improve voting system reliability and reduce problems with failing machines on election day,
- tighten security measures through digital signatures and other means to protect voting system software against unauthorized alterations, and
- ensure voting systems are relatively easy to use accurately based on the results of laboratory tests in which participants vote in mock elections.

The EAC must take public comments, make revisions based on those comments, and then take public comments again, so its new guidelines are not expected to take effect until January 2009, and they may differ somewhat from the Technical Guidelines Development Committee's recommendations.

The Dan Rather Report and Florida's 13th Congressional District

Staff reported to the Commission previously that one of the most recent DRE voting controversies erupted in Florida's Sarasota County over the 2006 election of a Congressperson for the state's 13th district. The part of the 13th district that lies in Sarasota County recorded a 13% undervote for the race (13% of the voters had no recorded vote in the race). Parts of the district that were in other counties recorded only a 2% undervote in the race. The likelihood that Sarasota County voters simply opted out while voters in other counties did not is

statistically unlikely, so the losing candidate (who lost by a margin of just 368 votes) challenged the results. The county conducted a test of the ES&S iVotronic machines in use and said that they were all working properly. The general consensus became that it was a ballot design issue, with people missing the race at the top of the screen with another high-profile race just below it.

An HDTV report by Dan Rather, *The Trouble with Touch Screens*, raised some questions about those same ES&S machines. The Rather report stated that the machines were manufactured in Manila and interviews with workers in the Manila factory revealed that about 40% of the touch screens were rejected for quality control issues. Technical documentation revealed that the company producing the ES&S screens had been warned internally that their process for making the touch screens left them vulnerable to failures in hot and humid weather. The Rather report stated that these same screens were used in Sarasota County in 2006.

Questions about the functioning of the machines that were thought settled have been raised again, and the EAC has requested an accounting from ES&S for its failure to disclose its use of the Manila assembly facility in its EAC certification information.

Additional Areas of Study

As reported to the Commissioners at the last meeting, TACIR staff is continuing its study of the election process in Tennessee by researching the following issues.

- voter eligibility/identification requirements
- voter database maintenance
- absentee and overseas ballots
- post-election audits
- recounts/intent of voter
- appropriate distribution of voting machines
- ballot design
- recruitment and training of poll workers
- election supersites/consolidated polling places
- consolidated election days/local and state elections o the same day

In order to gain insight into how these issues affect the ability to run elections at the local level, TACIR staff has prepared a survey for county election offices. A copy of the survey has been handed out to you today. We have also received correspondence from several city government officials concerning mostly the issue of consolidation of state and city election days. Letters have been received from the following city officials.

- Thomas C. Alsup, II, Mayor, City of Oak Hill
- Jeffrey J. Broughton, City Manager, City of Bristol
- Harold Craig, Mayor, City of Bells
- Bill Davis, Mayor, City of Charlotte
- W. Edward Ford, III, Mayor, Town of Farragut
- John D. Foster, Mayor, City of Tusculum
- William E. Gentner, Mayor, City of Columbia
- Jerry Gist, Mayor, City of Jackson
- David W. Gordon, Mayor, City of Covington
- Mike Helton, Mayor, City of Gatlinburg
- Carl Holder, City Manager, City of Paris
- Billy Myers, Mayor, Town of Mosheim
- Joe Reagan, Mayor, City of Brentwood
- Kenneth Wilber, Mayor, City of Portland

Thoughts and opinions of city and county government officials, gathered through both these letters and surveys, will certainly be considered as staff studies these issues.

Potential Improvements for Tennessee Elections

After reviewing what is known about voting machines, as well as practices in Tennessee and other states, TACIR staff suggests the following possible changes:

Implement voter-verified paper audit trails statewide within a reasonable time frame. Distrust of voting systems that are entirely electronic is widespread, undermines voter confidence, and may discourage voting. The current system allows no check of the electronically-generated count other than one that uses the same machines and software to recount the same electronically recorded votes. Though recounts of DRE totals sometimes uncover votes that went uncounted for various reasons, they do not include a count that is independent of the voting machines. If something unusual happens in the election, especially if it involves some kind of equipment malfunction, voters are simply unsatisfied if there are no physical ballots to recount. Staff has concluded that, if the cost is prohibitive, it would be preferable to move slowly to replace DREs with optical scan machines rather than to consider the currently available DRE printers.

Adopt VVPAT that can be counted by hand, as well as by machine—machine tallies to support prompt reporting of results with hand counting for audit and recount purposes. Not all VVPAT systems are created equal. Experience thus far with attaching printers to DREs has been unsatisfactory, mainly because of readability. Vendors are working on better systems, but they are still in the planning and experimental stages. Only precinct-level optical scan systems currently allow for verification and manual recounts and audits. Hamilton and Pickett Counties currently use optical scan systems countywide for most voters and have DREs for disabled voters. Ballot marking devices that can be used by disabled voters to mark their optical scan ballots in privacy, print them, and put them in the ballot boxes like all other voters are available.

Adopt a standard for VVPAT that matches that in the federal "Holt bill" and "Feinstein bill." While staff concludes that waiting for Congressional action is not advisable, it would be unwise to ignore the standards likely to emerge if Congress passes a bill. These standards cannot currently be met by DRE printers. If such printers were purchased and Congress passed the "Holt bill" or the "Feinstein bill," the new printers would have to be discarded.

Require voting machine vendors to escrow all of their proprietary software so that it can be reviewed by experts as recommended by the U.S. Election Assistance Commission and secured for further analysis if vote counting problems should arise. The inability to study the software when there are questions about the election seriously undermines confidence in the results of recounts and audits. Elections are the basis of democracy, and it is not acceptable for a private interest to shield a part of the election process from the voters they serve. Taxpayer dollars buy the voting machines and the software, and taxpayers have the right to ensure that their investment will produce reliable

results. The source code is the actual counter of votes, and that counting must be more open if the public is to accept close election outcomes. Vendors may have valid concerns about proprietary software, and those concerns should be addressed as much as practicable, but, at the very least, source code must be available for inspection by a limited number of qualified people who are not in the vendor's employ when an election is close and in question. Having a copy of the source code as delivered by the vendor would provide protection to vendors as well. In the event that the code was altered after delivery, vendors would have an official record of the code as they delivered it. A process that would allow for even more open examination of source code is desirable and should be explored for the future, even if it involves using voting machines with all open source code programs.

Strengthen post-election audit requirements to ensure that a minimum of machines are tested by comparing hand counts to machine totals and, if results vary by more than a small percentage, that a broader recount process follows. As has been demonstrated time and again, any machine counter can be programmed, maliciously or negligently, to miscount. Small miscounts might not create enough suspicion to ask for a recount—especially in a statewide or national race in which individual counties do not get as much notice. But, in any size race, systematic small miscounts can change the outcome. It is a wise practice to audit everything, whether problems are suspected or not. No one would suggest that either governmental entities or corporations only be audited when problems arise.

In most states that require these audits, a small number of precincts are randomly chosen to recount their ballots fully. Any discrepancies are investigated. If satisfactory explanations cannot be found, then all precincts will recount. Some states randomly select a percentage of ballots in all precincts and recount them manually. Any recount totals that do not fall within the statistical margin of error for the overall precinct total trigger a wider recount. As an alternative, several states also have an automatic partial or full recount only when the race was very close (generally when the top two candidates are within a point or two of each other). This saves candidates from having to appear to be sore losers by asking for a recount in a close race. The State of Minnesota enacted a post-election review law in 2004 to assess the accuracy of its voting machines. If the audit reveals a difference greater than 0.5%, a broader audit is automatically triggered.

Consider making early voting and voting by mail more accessible. Broadening the availability of both would take some pressure off of polling places on election day, addressing one of the concerns of recent elections—long lines and long waits. Furthermore, early voting has proved quite popular where it is widely available. It should be a real option for rural voters as well as for urban ones. More locations and a longer early voting period are options to consider. When voting by mail is an option, it is simply absentee voting. Tennessee

requires a reason to absentee vote. Most states do not. Allowing anyone who wishes to vote absentee would increase voting opportunity.

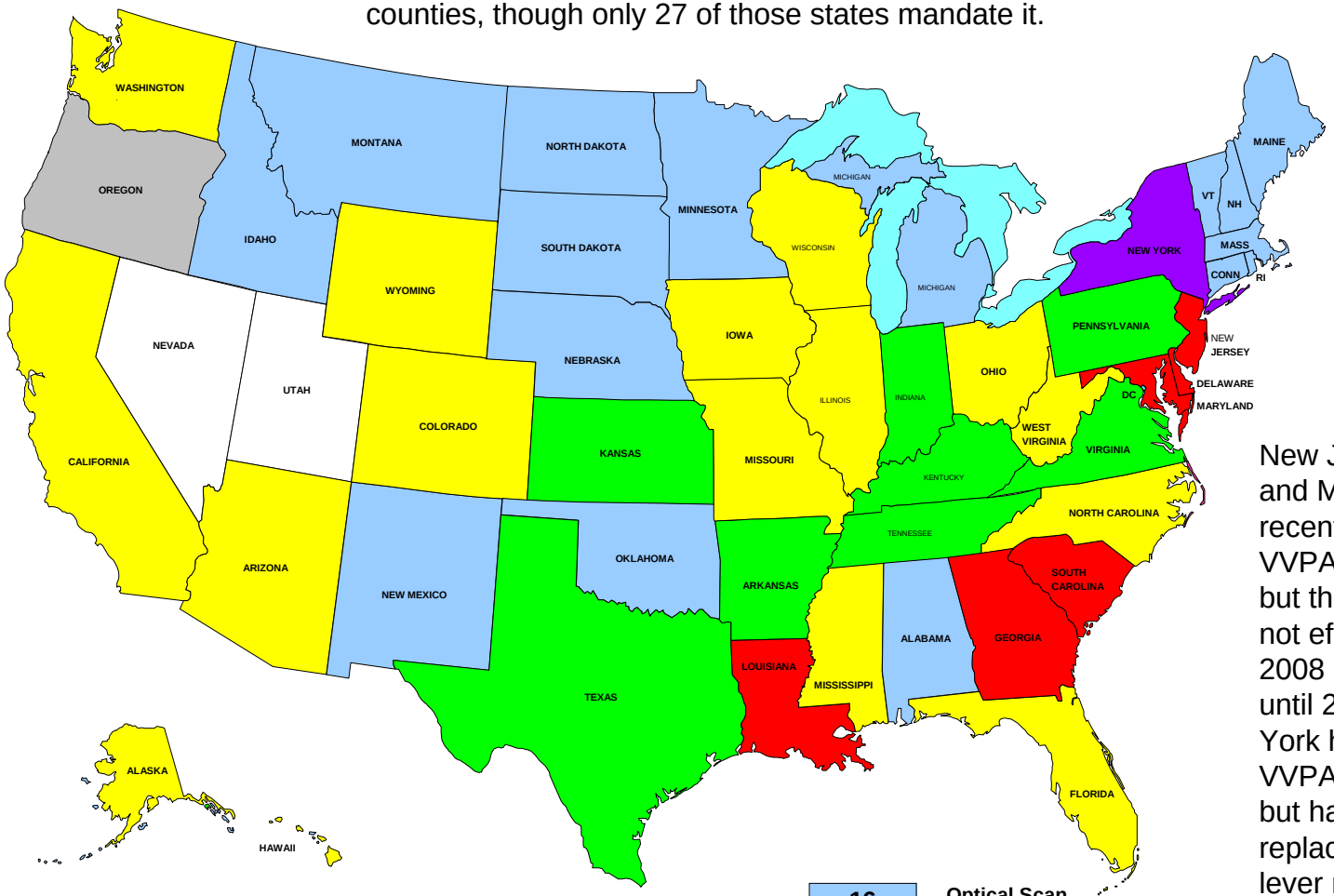
Consider a Vote by Mail pilot program that would allow the state to assess the advantages and disadvantages of this type of voting in Tennessee. States that use this are so excited about it that it seems worth trying. There are certainly potential problems, and it may not be for every state, but potential benefits include decreased expenses and higher turnout. A pilot program is the perfect way to find out if it works for Tennessee. The Joint Study Committee on the Voter Confidence Act of 2006 recommended a pilot program, and a bill currently in Congress would fund such a program if it passes.

Strengthen security and pre-test requirements and make them consistent for all voting systems. The rules that govern election procedure appear to have been updated hastily to include new technology. There are some inconsistencies in the testing requirements for different types of technology, and there is much that is out-of-date and no longer applies. While this is not necessarily critical to fair elections, it does need to be done at some point. And outdated rules could prove embarrassing if Tennessee should become the center of national attention in any election.

Consider election day parallel voting machine tests to detect hidden programs that are triggered by election day conditions and are erased so that they cannot be detected later. In this test, a voting machine in each precinct is chosen randomly to be removed from use and put on public display. Periodically, a ballot is run through it and its totals are checked to make sure it counted the ballot correctly. This would be a good measure to check election day performance of the machines and ensure they do not have hidden programs that will cause miscounts and that activate only on election day. The State of Maryland used this process in 2004, casting 1,300 ballots to test the reliability of their machines. If optical scan were to be adopted statewide, most counties would have only one counting machine per precinct. Parallel tests could still randomly select at least one machine per county to test openly on election day.

Electronic Voting Systems in the United States

The 15 states (plus Washington, DC) in red, purple, and green have at least some counties with no paper trail. The other 35 states do have a paper trail in all counties, though only 27 of those states mandate it.



8+DC — Optical Scan and DRE

6 — DRE

1 — Lever and DRE with VVPAT

16 — Optical Scan

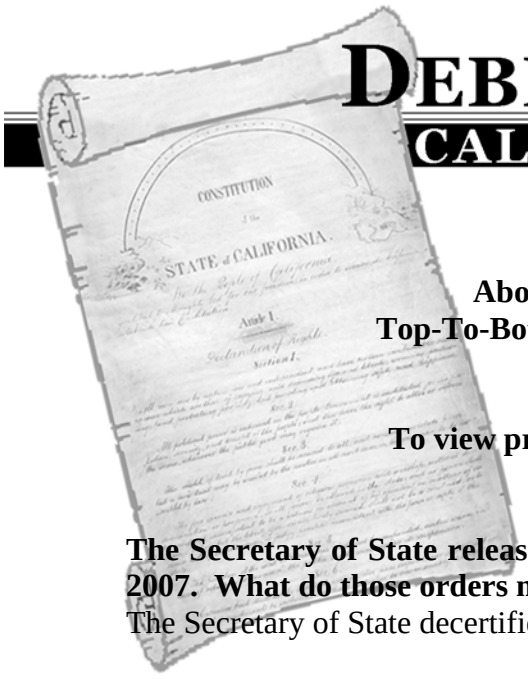
16 — Optical Scan and DRE with VVPAT

2 — DRE with VVPAT

1 — Vote by mail

New Jersey, Virginia and Maryland recently passed VVPAT legislation, but the first two are not effective until 2008 and the last until 2010. New York has passed a VVPAT requirement but has not yet replaced all of its lever machines.

Source: www.electionline.org



DEBRA BOWEN
CALIFORNIA SECRETARY OF STATE
NEWS RELEASE

Frequently Asked Questions
About Secretary of State Debra Bowen's
Top-To-Bottom Review of California's Voting Systems

Revised August 15, 2007
To view prior versions of this FAQ, please click here.

The Secretary of State released her decertification and recertification orders on August 3, 2007. What do those orders mean?
The Secretary of State decertified the following voting systems on August 3, 2007:

- Diebold GEMS 1.18.24/AccuVote TSX/AccuVote-OS
- ES&S InkaVote Plus Precinct Ballot Counter Voting System, version 2.1
- Hart Intercivic System 6.2.1
- Sequoia WinEDS version 3.1.012/Edge/Insight/400-C

She then recertified all but one system (the ES&S InkaVote Plus Precinct Ballot Counter Voting System, version 2.1) with a number of conditions. A detailed list of all of the conditions for each system can be found by **clicking here**, but in brief, the conditions require:

- Counties that use any one of the six systems must adopt security procedures detailed in the recertification documents.
- For counties using direct recording electronic (DRE) machines made by Sequoia and Diebold, no more than one such machine may be used per polling location on Election Day. Elections officials must conduct a 100% manual count of the voter-verified paper audit trail (VVPAT) for votes cast on those machines.
- All six systems will be subject to increased post-election audits to ensure election results are accurately tabulated.

How will counties and voters be affected by this decision?
Nearly nine million California voters cast ballots in the November 2006 gubernatorial election and over 75% of them voting using either a paper-based absentee ballot or a paper-based optical scan ballot.

Of California's 58 counties, 35 of them rely primarily on a paper-based optical scan system for their Election Day balloting. Most of them use one DRE in each polling place to comply with the Help America Vote Act (HAVA) requirement to enable voters with disabilities to vote privately and independently. These counties will have to comply with a number of security and post-election audit requirements, but by and large, voters in these counties won't see any change when they go to the polls on Election Day.

Two counties rely on the Hart Intercivic DRE for their polling place voting system. These counties will have to comply with a number of security and post-election audit requirements, but by and large, voters in these counties won't see any change when they go to the polls on Election

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Day.

Twenty-one counties rely on either the Sequoia Edge I, the Sequoia Edge II, or the Diebold TSx DRE systems for their polling place system. Except for the single DRE allowed per polling place, these counties will have to adopt a new Election Day voting system. It is in these 21 counties where voters will notice the biggest change on Election Day.

For a list of voting systems by county, please **click here**.

Why wasn't the InkaVote Plus voting system recertified?
ES&S, the provider of the InkaVote Plus system, didn't provide the equipment and information necessary for that system to be included in the review in a timely fashion. The Secretary of State intends to put this system through the same rigorous testing process the other systems in the top-to-bottom review process were subjected to. Depending on the results of the review, that system may be recertified in time for it to be used in the February 2008 presidential primary election.

How much did the review cost and where did the funding come from to pay for it?
Approximately $450 million has been spent or set aside to upgrade California's voting equipment over the past several years.

The total cost of the top-to-bottom review was originally estimated to be $1.8 million, but because fewer systems were reviewed than was anticipated, the cost to date has been $905,000.

A portion of the money used to conduct the review came from the $760,000 in federal HAVA funding that was provided by the Legislature for voting machine source code review as part of the 2006-07 state budget. The remaining funding for the review came from the voting system vendors. It's estimated the review of each system cost approximately $262,000, with the costs being split equally between the vendor and California's HAVA funding allocation. California law, as well as the certification agreements many of the voting system vendors signed with the former Secretary of State, allow the Secretary of State to review voting systems at any time and allow the Secretary of State to require vendors to pay for the cost of conducting the review.

Why was it necessary to conduct a top-to-bottom review of California's voting systems?
The top-to-bottom review was designed to give California's voters an answer to one simple question: Are all of California's voting systems secure, accurate, reliable and accessible?

Furthermore, Elections Code Section 19222 requires the Secretary of State to review the voting systems Californians are asked to cast their ballots on, stating:

> The Secretary of State shall review voting systems periodically to determine if they are defective, obsolete, or otherwise unacceptable. The Secretary of State has the right to withdraw his or her approval previously granted under this chapter of any voting system or part of a voting system should it be defective or prove unacceptable after such review. Six months' notice shall be given before withdrawing approval unless the Secretary of State for good cause shown makes a determination that a shorter notice period is necessary. Any withdrawal by the Secretary of State of his or her previous approval of a voting system or part of a voting system shall not be effective as to any election conducted within six months of that withdrawal.

What is a top-to-bottom review of California's voting systems?
The top-to-bottom review consisted of a thorough examination of all voting system documentation, procedures and the equipment used to record and tally votes. The review had four components:

- A document review examined manufacturer documentation, testing reports from federal Independent Testing Authorities (ITAs), reports from prior state certification testing, and reports of independent examinations and testing of voting systems.

- A source code review examined the human-readable instructions that are converted into machine-readable code to run the voting systems. The primary focus was to identify any security vulnerabilities that could be exploited to alter vote recording, vote results, critical election data such as audit logs, or to conduct a "denial of service" attack that prevents people from voting.

- Red team penetration testing involved open-ended, hands-on efforts to identify and document any potential for tampering or error in any part of the voting system's hardware, storage devices or software.

- The accessibility of the voting systems was assessed and included test voting on each of the voting systems by volunteer voters representing a broad range of disabilities.

The document review teams, source code review teams and red teams interacted regularly to learn from one another and to ensure the review of all systems is even-handed.

How were the voting systems evaluated and did that differ from the draft criteria published on March 22?
The draft criteria was an initial proposal for discussion and public input. Based on the substantial number of comments received, the final project plan used to evaluate the voting systems didn't include those draft standards. Instead, the top-to-bottom review teams provided an independent technical evaluation of the voting systems that the Secretary of State used to carry out her statutory duty with respect to voting systems, as required by Division 19 of the State Elections Code.

The standards and definitions for security, accuracy, reliability and protection of ballot secrecy governing the top-to-bottom review are set forth in the federal 2002 Voluntary Voting System Standards, which may be found at http://www.eac.gov/election_resources/vss.html. California Elections Code Section 19250 requires voting systems to comply with these standards as a condition of being certified for use in the state.

With respect to accessibility for voters with disabilities and with alternative language requirements, the standards and definitions governing the top-to-bottom review are set forth in the 2005 federal Voluntary Voting System Guidelines, which may be found at http://www.eac.gov/VVSG%20Volume_I.pdf and in California Elections Code Sections 19227, 19250 and 19251.

The red team penetration testing was conducted in accordance with Resolution # 17-05 of the Technical Guidelines Development Committee (hereafter "TGDC") of the U.S. Election Assistance Commission, adopted at the TGDC plenary meeting on January 18-19, 2005, which calls for:

> ". . . testing of voting systems that includes a significant amount of open-ended research for vulnerabilities by an analysis team supplied with complete source code and system documentation and operational voting system hardware. The vulnerabilities sought should not exclude those involving collusion between multiple parties (including vendor insiders) and should not exclude those involving adversaries with significant financial and technical resources."

Who conducted the review?
The Secretary of State contracted with the University of California (UC) to assemble three top-to-bottom review teams that relied on specialists from UC, as well as from public and private universities and private sector companies throughout the United States. To ensure a fresh look at the voting systems, scientists with specific experience in voting system technology and security experts from other fields who had no experience with voting system technology were asked to participate. Each review team consisted of at least seven members and included three components – document review, source code review, and red team penetration testing.

- The two Principal Investigators for the project were Matthew Bishop, Professor in the Department of Computer Science and Co-Director of the Computer Security Laboratory at UC Davis, and David Wagner, Associate Professor in the Computer Science Division at UC Berkeley, with extensive experience in computer security, cryptography and electronic voting. David Wagner is a founding member of the ACCURATE center, which is funded by the National Science Foundation to research ways that technology can be used to improve voting.

The accessibility of the voting systems was assessed by a single team of two accessibility experts, headed by Noel Runyan, an electrical engineer and computer scientist with over 33 years experience in designing and manufacturing access technology systems for people with disabilities. The accessibility assessment included test voting on each of the voting systems by volunteer voters representing a broad range of disabilities.

For a complete listing of team members, as well as resumes, biographies, and/or curriculum vitaes, please **click here**.

What if a voting system vendor chose not to participate in the review?
If a vendor chose not to have its voting system reviewed, the Secretary of State had the option of initiating a decertification process immediately. The Secretary of State could also impose conditions on the use of such systems, even though they had not been through the top-to-bottom review, in the event a vendor would like to have a county use such a system in 2008.

What happens with new voting systems that receive federal approval?
If a system received federal approval and was submitted to the Secretary of State by July 1, 2007, for certification in California, the Secretary of State will fully review that system using the same standards that were applied in the top-to-bottom review.

What if a vendor opted out of having its existing system tested in anticipation of federal approval later this year for a replacement system?
Any system that was not federally certified and submitted to the Secretary of State by July 1, 2007, will not have sufficient time to complete the state certification process before the February 2008 election. Therefore, if a vendor opted out of the top-to-bottom review but did *not* submit a replacement system for certification by July 1, 2007, the Secretary of State may either decertify or conditionally recertify the existing system for 2008 elections with additional restrictions.

Did the top-to-bottom review test entire voting systems or only the voting machines used in polling places?
The only way to make sure a voting system is properly recording and counting votes is to review a voting system from top to bottom. That's why the review included all of the various machines used to *cast* ballots, as well as the systems used to *count* ballots, including vote tabulating devices, election management and tabulation programs, and associated firmware, software and peripheral devices.

What systems were tested?
The following certified voting systems were examined and tested under the top-to-bottom review:

Diebold GEMS 1.18.24/AccuVote
- GEMS software, version 1.18.24
- AccuVote-TSX with AccuView Printer Module and Ballot Station firmware version 4.6.4
- AccuVote-OS (Model D) with firmware version 1.96.6
- AccuVote-OS Central Count with firmware version 2.0.12
- AccuFeed
- Vote Card Encoder, version 1.3.2
- Key Card Tool software, version 4.6.1
- VC Programmer software, version 4.6.1

Hart Intercivic System 6.2.1
- Ballot Now software, version 3.3.11
- BOSS software, version 4.3.13
- Rally software, version 2.3.7
- Tally software, version 4.3.10
- SERVO, version 4.2.10
- JBC, version 4.3.1
- eSlate/DAU, version 4.2.13
- eScan, version 1.3.14
- VBO, version 1.8.3
- eCM Manager, version 1.1.7

Sequoia WinEDS version 3.1.012/Edge/Insight/400-C
- WinEDS, version 3.1.012
- AVC Edge Model I, firmware version 5.0.24
- AVC Edge Model II, firmware version 5.0.24

- VeriVote Printer
- Optech 400-C/WinETP firmware version 1.12.4
- Optech Insight, APX K2.10, HPX K1.42
- Optech Insight Plus, APX K2.10, HPX K1.42
- Card Activator, version 5.0.21
- HAAT Model 50, version 1.0.69L
- Memory Pack Reader (MPR), firmware version 2.15

Were any systems not reviewed by the Secretary of State s part of the top-to-bottom review?
The DFM Mark-A-Vote system used by Lake, Madera, and Sonoma counties was not reviewed in this round of testing, but the Secretary of State reserves the right to conduct a review of this system at a later date.

The Opto-Mark system, operated by Martin & Chapman Company and used in several cities to conduct local elections, was not reviewed in this round of testing, but the Secretary of State reserves the right to conduct a review of this system at a later date.

The Votec system, used by the City of Los Angeles to conduct local elections, was not reviewed in this round of testing, but the Secretary of State reserves the right to conduct a review of this system at a later date.

ES&S declined to submit its Unity 2.4.3.1/AutoMARK and its City and County of San Francisco Voting System to the top-to-bottom review because it doesn't intend to have any county use those systems in 2008. Should ES&S attempt to have a county use those systems, the Secretary of State has the right to attach additional use conditions to the systems pursuant to the 2006 certification of the systems, regardless of the fact that they weren't submitted for inclusion in the top to bottom review.

As noted earlier in this document, ES&S didn't submit its InkaVote Plus Precinct Ballot Counter Voting System, version 2.1, in time for it to be included in the review, despite the fact that the sole California user of this system – Los Angeles County – intends to use the system in 2008. As a result, the Secretary of State has decertified the system, but intends to conduct a review of this system soon and has the right to recertify it depending on the results of that review.

Hart Intercivic declined to submit its System 6.1 to the top-to-bottom review because it doesn't intend to have any county use that system in 2008. Instead, Hart Intercivic has voluntarily opted to decertify that system, meaning the Intercivic System 6.1 won't be used by any city or county in 2008.

Los Angeles County declined to submit its Microcomputer Tally System (MTS) version 1.3.1 to the top-to-bottom review because it intends to move to an alternate system in 2008. Should it decide to use the system in 2008, the Secretary of State has the right to attach additional use conditions to the system, regardless of the fact that it wasn't submitted for inclusion in the top-to-bottom review. A link to a letter detailing Los Angeles County's decision not to submit its system to the top-to-bottom review can be found **here**.

Where was the top-to-bottom review being conducted?
Testing, examination and review activities, and analysis were conducted onsite at the Secretary of State's facilities in Sacramento under secure conditions, with one exception. The review of documentation and source code was, upon express written authorization of the Secretary of State, conducted at secure facilities of UC or other secure locations designated by UC.

Was this review open to the public?
Given the proprietary nature of the systems being reviewed and the legal requirements to protect the intellectual property of the vendors, the ability to conduct the review in a completely public fashion was severely constrained. However, the Secretary of State created a public observation room that allowed any member of the public to watch the review process via the security cameras that were set up in the testing facility. The Secretary of State maintained an updated telephone hotline to allow anyone to call in and find out what the testing schedule was for the following day, so they could determine if they wanted to come to the public observation room to view it.

How can I read the reports prepared by the independent UC review teams?
You can **click here** to get back to the main Top-To-Bottom Review Page, where you'll find copies of the UC top-to-bottom review reports and more information about the entire top-to-bottom review process.

Trust But Verify: Toward Increasing Voter Confidence in Election Results

Executive Summary

With talk of amending the Help America Vote Act (HAVA) and the possibility of additional federal funds to implement voter verified paper audit trails (VVPAT) for the 2008 or 2012 presidential elections swirling about, Tennessee's local election commissions once again face the possibility of changing their voting systems. This may be a good thing. Lack of voter confidence in the machinery and process of elections is running high despite replacement of voting systems all across the country. Tennessee has not been immune. A group of voters in Memphis and Shelby County were sufficiently concerned to hire an elections expert to review reports of problems there and remain distrustful of the system.

A 2006 Zogby poll[1] of likely voters found that

- 61% are aware that there have been reports of flaws in electronic voting machines that make it possible to tamper with one machine in such a way as to change the results of an entire election,
- 80% believe that it is unacceptable for votes to be counted in secret without any outside observers from the public, and
- 92% feel that citizens have a right to view and obtain information about how election officials count votes.

Tennessee is one of only 20 states that require neither a voter verified paper audit trail (VVPAT) nor a routine post-election audit. Eight of those 20 states have VVPAT statewide, though it is not specifically required. Despite the concerns expressed by voters, only 15 states require both, and 15 more require some form of VVPAT, but no audit.

Even if Congress does not amend HAVA and fund VVPAT, Tennessee may wish to address the concerns of voters on its own. This report, an early release on a broader study of election reform issues authorized by the Tennessee Advisory Commission on Intergovernmental Relations (TACIR) in December 2006, focuses on VVPAT because implementation of changes in voting technology require more time than other reforms. We hope that this report, as well as the broader study, will be of assistance to the special joint committee established by SJR 745 (formed to study the Tennessee Voter Confidence Act of 2006*).*

Background

The lack of voter verification is certainly not new. Though the earliest American elections made use of voice votes recorded on paper by multiple observers and paper ballots, the first mechanization of elections relied on lever machines. These machines could be easily manipulated by turning dials in the back, and their vote records were

notoriously unreliable even when used correctly. With years of storage between uses, the gears that counted the votes could become sticky and rusted and affect the vote count.

Computer-read ballot systems first appeared in the 1960s and began quickly to displace mechanical machines. Voters either punched a card or used a No. 2 pencil to mark a standardized form; both could be read by a person or a computer. Computer touch screens and direct recording electronic (DRE) machines were first introduced in the 1990s and have been used by some Tennessee jurisdictions now for more than a decade.

By the November 2006 general election, only New York and Idaho retained any of the older voting technologies. Most states now use optical scan machines, DREs, or some mixture of the two, though a number of counties in ten states still use hand-marked, hand-counted paper ballots.

The Help America Vote Act

On October 29, 2002, President Bush signed the Help America Vote Act (HAVA) into law imposing a January 2006 compliance deadline on states. According to the National Association of Secretaries of State, states had to

- implement a system that notifies voters if they "over vote" and gives them the opportunity to correct their ballots;
- utilize a voting system that produces a permanent paper record with a manual audit capability;
- provide disability access equal to the level of access, privacy, and independence available to other voters; and
- define uniform standards for what constitutes a vote on each type of voting equipment used in the state.[2]

As implemented in many states, including Tennessee, HAVA's manual audit capacity does not require a paper record of each voter's selections. Instead, it consists of printouts run prior to any voting showing that the machines have no votes tallied, and printouts run after the polls close showing the vote totals for each machine. Both sets of printouts are often publicly displayed; in Tennessee such displays are required. DREs also keep an electronic record of each ballot, but these rely on the same electronic count that produces the vote totals. They are not filled out by the voter and are not voter-verified auditable records.

As a result of HAVA, most jurisdictions across the country opted for one of two types of voting systems. Some chose the new breed of DREs that were more interactive than previous models and could warn voters of ballot problems. These DREs also have audio capacity and other accessibility features that allow voters with disabilities to be guided through the voting process privately. Other jurisdictions chose precinct-level

optical scan systems with at least one other type of machine per precinct that allowed private handicapped access. Two Tennessee counties chose precinct-based optical scan with DREs for disabled voter access; the other 93 counties use DREs.

Documented DRE Problems in Tennessee and Other States

There are no formal requirements or methods for reporting voting problems in Tennessee or nationally. At every election, some reports of problems appear in the press, and there are organizations that gather those press reports and make them available to the public. Such lists are useful but can by no means be considered complete. One of the most comprehensive of such lists is presented on the website VotersUnite.org. It lists 9 reports of problems in Tennessee over the last several years, with all 4 of Tennessee's current voting machine vendors appearing at least once. The characterizations and descriptions of those problems are directly from their website. All include links to the original press accounts.

Date	Problem Type	Vendor	Description
11/9/2006	Machine malfunction	Hart InterCivic	Knox County. Circuitry in a Hart InterCivic eSlate fails, calling into question over 2600 e-ballots. *Knox County Election Commission Chair Pamela Reeves explains what happened to the machine. "Apparently,* ***what it did was it smoked.*** *I don't know what caused it to smoke, but it was literally smoking. So they unhooked it at the time. Of course, we don't read the votes and we didn't know there was a problem until we went to read the votes Tuesday night."* Story Archive
11/7/2006	Machine malfunction	ESS	Williamson County. Only two ES&S iVotronic touch screens worked in Grassland precinct. Story Archive
11/7/2006	Machine malfunction	ESS	Hawkins County. ES&S iVotronic touch screens didn't work. *Most of the voting machines were down until noon, according to Peggy Fleenor, the county's election administrator. The problem resulted after officials ran a program before opening to clear the vote totals to zero.* Story Archive
11/3/2006	Malfeasance	Diebold	Shelby County. Several electronic voting cards, used to cast ballots on Diebold touch screens, are missing from a polling place in Memphis, according to the Tennessee Republican Party. *"Once cast, an illegal vote made with the reprogrammed Smartcard would be indistinguishable from a legally cast vote," Davis wrote.* Story
11/2/2006	Machine malfunction	Hart InterCivic	Sullivan County. The control device (Judges Booth Controller - JBC) for Hart InterCivic eSlate voting machines shut down after 10,000 ballots were cast in early voting. The JBC would hold no more ballots in its memory. Voters waited while the county replaced the machine. Officials don't expect

			this problem on election day since no precincts have 10,000 voters. Story Archive
11/2/2006	Poor design		Marble Falls. Voting on computers confuses voters, who are used to paper ballots. *"In the old days, we used paper ballots. Sometimes we used more than one ballot so I thought I need to cast this ballot, then the Marble Falls propositions would come up, then I could vote on that. I pushed the button to cast the ballot, it said I had done everything. I was finished,"* Story
10/18/2006	Machine malfunction	Diebold	Shelby County. Two women were given the wrong ballot for the Diebold touch screen. For one, the Germantown races -- not her town -- appeared first. For the other, those races appeared last. When she looked for a poll worker to inform about the problem, the machine timed out, cancelled her ballot, blanked the screen, and ejected her voter card. With no proof that her ballot had been cancelled, she was not allowed to vote a regular ballot, but only given a provisional ballot. Story Archive
May 2005	Machine malfunction	Microvote	Sumner County. 110 votes could not be retrieved on election night. Story
August 2002	Machine malfunction	Microvote	Putnam County. None of the vote totals matched up with the correct candidates. Story

This same website lists 273 reported problems nationally for just 2006 and 2007. Not included in this report were the problems identified in Shelby County during its primary in 2006. Four losing candidates for various local Shelby County elections asked to see the central tabulator database—a request they had to make in court. They hired Jim March, an election machine investigator from California, to review the records. His report noted numerous security breaches.

- Illegal and uncertified software was present that would allow data transfer on small USB “key chain” devices, hand-editing of vote totals, improper reporting of election results, and remote control of the central tabulator.

- Evidence in the activity log showed repeated failed attempts to use an HTML editor, which would allow manipulation of election reporting results. Successful attempts would not show in the log, so it cannot be known if any attempts succeeded.

- There was no router or firewall protecting the central tabulator, leaving it open to access by any county government official.

- A record of use of Windows programs showed frequent use of Microsoft Access, a database program known to provide opportunity to alter results on Diebold voting machines.

These irregularities are the subject of an ongoing federal civil rights lawsuit.

As an example of the limited nature of these accounts, in addition to the exclusion of the Shelby County story, a representative of Common Cause reported on two Davidson County voters who failed to get the proper ballot in 2006, one of them a candidate's spouse. Neither of these voter's complaints, made it into the website database. The problems listed at this site should be considered only a sample of the actual problems encountered by voters, yet it is the most comprehensive list that TACIR staff could find.

One of the more infamous cases from the November 2006 election was in Florida. Florida's 13th Congressional district race had an overall under-vote rate (the percentage of voters who left the Congressional race blank) of 2%, but the Sarasota County portion of the district registered a 13% under-vote in the race. The official verdict on these troubles was poor ballot design that made voters miss the race on the computer screen, but the inability of the losing candidate to get a meaningful recount or examine the proprietary voting software greatly increased distrust of DREs. Because of the continued problems with electronic voting machines and the lack of a paper trail, current Florida Governor Charlie Crist pushed for legislation to implement optical scan systems statewide. He signed the legislation in May 2007, appropriating nearly $28 million to replace Florida's DRE's, leaving just enough of the touch screen machines to comply with HAVA's disability requirements.

A March 2007 Government Accountability Office (GAO) study found that improvement was needed at all levels of government. Specifically, the report found inadequacies in national standards, system design and development, operation and management activities, and testing. Additionally, the report cited wide variances in state and local standards, including types of testing that are not commonly performed.

The Cost of Adding a Paper Trail

Studies have repeatedly shown that optical scan systems have lower up-front costs than DREs, but that ballot printing costs may make DREs the less expensive option if they remain in use beyond about 20 years. [3] Other studies have refuted the idea that DREs ever become cost-competitive with optical scan systems, showing that DREs do not last for 20 years and that many more DREs per precinct are required compared to optical scan counting machines to provide adequate access to voters.

Several bills introduced in the last General Assembly aimed at creating a VVPAT include a fiscal note that was based on adding printers to the DREs currently in use in 93 counties. That was estimated as a one-time $9.5 million expense.

None of the bills was interpreted to mean replacing the DREs with optical scan machines, though the State Election Coordinator's office made a rough estimate of a one-time $25 million expense, with unestimated ongoing costs due primarily to ballot

printing. This estimate was based on $10,000 to purchase one optical scan ballot counter and one automatic ballot marking device per precinct. The latter is for disability access. It is essentially a DRE that prints an optical scan ballot rather than counting the vote.

In testimony before the Elections Subcommittee of the Congressional Committee on House Administration, Warren Stewart, Policy Director of VoterTrustUSA, gave similar cost estimates of $10,000 per precinct for both an optical scan tabulator and a ballot marking device. He further explained that those machines cost about $5,000 each.

Tennessee has 2,256 precincts and 135 of those (126 in Hamilton County and 9 in Pickett County) already have optical scan machines. An estimate that is a little less rough would be $10.6 million to purchase an optical scan machine for each of the 2,121 precincts that lack them and $11.3 million to purchase automatic ballot marking devices for all 2,256 counties (Hamilton and Pickett Counties currently use DREs for disability access). It would also be possible to do as Florida has done and maintain one DRE per precinct for disability access, allowing the total change to take place for $10.6 million.

Adding a paper trail of any kind will, of course, add the cost of paper and its storage. The differences between the two systems on paper costs are not as clear. Thermal rolls may use less storage space, but, unlike optical scan ballots, they require controlled climates. Thermal paper rolls are certainly less expensive to purchase than are printed ballots.

A North Carolina study showed that the additional costs associated with maintaining so many more voting machines and printer attachments in counties using DRE machines resulted in higher election costs on an ongoing basis than ongoing election costs in optical scan counties. The two DRE counties in the study, Wake and Durham, averaged about $5.01 per voter per election when all costs were considered. The optical scan counties, Guilford and Mecklenburg, averaged $3.59 per voter.[4] In addition, an analysis of Georgia's costs showed that support, maintenance, and operation costs over a six year period were about 50% higher for DREs than for optical scan.[5]

Tennessee's largest county to use optical scan currently, Hamilton County, reports that ballot printing costs about 15 to 20 cents per ballot. The county also reports that they do not have to print excessive numbers of ballots, even for early voting, and that the ballot-printing costs associated with their optical scan system are not prohibitive. If early voting with its attendant central voting locations does require substantial ballot printing costs, the option of "ballot on demand" exists.

Ballot on demand is a system allowing poll workers to print the proper ballot for a voter when he arrives to vote, eliminating the need for estimating the number of each type of ballot needed and overprinting to be sure enough ballots will be available. Florida, which is switching to optical scan for all of its counties, will make use of ballot on demand for early voting.

Experiences with the VVPAT technology that has thus far been adopted for DREs shows additional costs when recounts are needed or when audits are required. The photo below is of a Clark County, Nevada election worker holding one end of a 318-foot VVPAT tape. This tape contains only 64 ballots.

Photo reprinted with permission of Larry Lomax, Registrar of Voters, Clark County, Nevada

The County of San Bernardino in California served as a pilot program for VVPAT during the November 2004 presidential election. Only 270 of the 1,495 voters in the precinct used it to cast their ballots. A joint report by the San Bernardino County Registrar of Voters and Sequoia Voting Systems characterized voters' comments about their experiences as positive; however, the manual recount that followed as part of the pilot was not.

Three teams of two staff members each worked two 8-hour days to recount every race on the ballot—adjusting for human counting errors along the way—and confirm that the totals on the paper rolls matched the electronic tally for every race. That works out to 270 ballots recounted in 96 staff hours, which equates to either 2.8 ballots per hour or just over 21 minutes per ballot. The cost of recounting or auditing election results with such a system would be so prohibitive as to be essentially impossible.

Audit Requirements

Fifteen states with paper-based ballot systems or electronic voting with paper trails require manual post-election audits in which a percentage of precincts are fully recounted by hand or a portion of ballots or paper records are counted by hand and

compared to the total in their precinct for consistency (inconsistencies can lead to full recounts). In addition, Nevada requires either a manual or a mechanical audit. Texas requires that a percentage of electronic ballot images be printed and hand-counted, though these are generated by the same software that initially counts the votes. Pennsylvania and Kentucky require hand count audits, though the method is not specified and they both use at least some paperless voting systems. Maryland requires an audit of election records, including signed voter authority cards, precinct registers, and other polling place forms.

Tennessee has no specific audit or recount requirements and only conducts such checks upon specific complaint. Audit requirements are an important subject in themselves and will be studied further in later portions of the TACIR examination of election procedures, but paper alone will not suffice to create a high level of confidence in election results. A consistent, mandatory audit process is needed in Tennessee.

Seven bills filed in the General Assembly during the last session require some form of paper audit trails. All were referred to their respective State and Local Government Committees, which put them in subcommittee pending a recommendation by the Joint Study Committee on the Voter Confidence Act of 2006.

Early Voting, Absentee Voting, and Vote By Mail

One of the concerns with VVPAT is the extra time it will take voters to complete the voting process. This can mean longer lines, decreased poll access, and extra expenditures for more voting machines. One of the best ways to deal with these expenses is to take some of the pressure off of polling places on election day through the use of early voting and voting by mail (no excuse absentee voting).

Tennessee is one of 31 states that allows no-excuse early voting or in-person absentee voting. Only five of those 31, including Tennessee, require an excuse to vote absentee by mail.[6] Oregon and most of Washington's counties vote exclusively by mail. The system is popular with their voters and these states report many advantages, including lower administrative costs and higher turnout.

Verifying the Software—Source Code and Trade Secrets

Among the concerns about DRE voting machines is the inability to review the software or programs that store and tally the votes. The software is called "source code," and the main impediment to its disclosure is state "trade secrets" law. Source code is a sequence of instructions written by a computer programmer in a high-level language like FORTRAN or COBOL that is readable by people but not by computers. Source code must be converted into object code by a compiler or interpreter in order to be executed by a computer. Source code is proprietary information that is protected by copyright law and trade secrets law.[7]

Copyright law protects against the unauthorized copying of proprietary information, so analyzing source codes would not violate copyright law. Trade secrets are information such as a formula, pattern, compilation, program, device, method, technique, or process that derives economic value from not being generally known and is subject to

reasonable efforts to preserve confidentiality. Businesses use trade secrets to secure advantage over others in the same industry. Trade secret law prevents others from misappropriating and using the trade secret. It may prevent access to voting machines' software source codes.

Trade secret law is generally adjudicated at the state level, though federal preemption of state laws would be possible.

Placing Source Code in Escrow

As a part of its software licensing agreements, a vendor will often place its software source code with a third-party escrow agent so that the person or business holding the license will still have access to it if the vendor goes out of business. The escrow agent simply holds the software for the parties to the license but cannot read or access it. A number of companies specialize in software escrow.

The Commission on Federal Election Reform endorsed this technique for voting machine software in its final report issued in September 2005, *Building Confidence in U.S. Elections*:

> *Manufacturers of voting machines have legitimate reason to keep their voting machine software and its source code proprietary. The public interest in transparency and the proprietary interests of manufacturers can be reconciled by placing the source code in escrow with the National Institute of Standards and Technology (NIST), and by making the source code available for inspection on a restricted basis to qualified individuals. NIST might make the source code available to recognized computer security experts at accredited universities and to experts acting on behalf of candidates or political parties under a nondisclosure agreement, which could bar them from making information about the source code public, though they could disclose security flaws or vulnerabilities in the voting system software.*[8]

Third-Party Software

Many voting machines make use of software from other companies, primarily Microsoft. With Windows-based programming, voting machine vendors are not able to make source code public without the permission of Microsoft. And Microsoft has made clear that such permission will never come. If source code is to be made public, vendors will have to completely revamp their software so that it is based on open-source operating systems such as Linux. Experts suggest that such a move is feasible if adequate time is given to achieve it.[9]

The Federal Election Assistance Commission (EAC)

The EAC was established in 2002 by HAVA. It is meant to be a national clearinghouse and resource for federal elections information and procedures. HAVA required the EAC to

- generate technical guidance on the administration of federal elections;

- produce voluntary voting systems guidelines;
- research and report on matters that affect the administration of federal elections;
- otherwise provide information and guidance with respect to laws, procedures, and technologies affecting the administration of Federal elections;
- administer payments to states to meet HAVA requirements;
- provide grants for election technology development and for pilot programs to test election technology;
- manage funds targeted to certain programs designed to encourage youth participation in elections;
- develop a national program for the testing, certification, and decertification of voting systems;
- maintain the national mail voter registration form that was developed in accordance with the National Voter Registration Act of 1993 (NVRA), report to Congress every two years on the impact of the NVRA on the administration of federal elections, and provide information to States on their responsibilities under that law;
- audit bodies who received federal funds authorized by HAVA from the General Services Administration or the Election Assistance Commission; and
- submit an annual report to Congress describing EAC activities for the previous fiscal year.

Toward its mission, the EAC has produced a Best Practices Tool Kit for election administration. The kit includes solutions, examples, and suggested resources for voting systems in general and specifically for each type of system, including DRE systems. The tool kit includes recommendations for security and management of systems prior to, the day of, and after election day. Neither the recommendations for DRE systems nor those for any of the other systems specifically include the use of voter verified paper audit trails.

Federal Legislative Action

Two bills in the U.S. Congress are currently under consideration that would require paper trails, the “Voter Confidence and Increased Accessibility Act of 2007” (also known as the “Holt bill”) and the “Ballot Integrity Act of 2007” (also known as the “Feinstein bill”). There are two additional bills, the “Count Every Vote Act of 2007” has thin support in the House, and most of its Senate sponsors have also sponsored the Feinstein bill, which has much more momentum, though it lacks a House companion bill. The “Verifying the Outcome of Tomorrow’s Elections Act of 2007” has only one House cosponsor and no Senate companion bill.

The Holt bill (H.R. 811), introduced by Representative Rush D. Holt of New Jersey, would require that the voting system use or produce

> *an individual voter-verified paper ballot of the voter's vote that shall be created by or made available for inspection and verification by the voter before the voter's vote is cast and counted.*

The paper ballot can be produced by various methods—hand marking, optical scan, DRE, or other machines—as long as the voter is allowed to verify the ballot in paper format. The paper record would be the ballot of record for all recounts and audits. Paper ballots would be on archival quality paper and would be maintained for audit purposes, but not in a manner that would allow the confidentiality of an individual's vote to be compromised. As currently written, the bill would require that ballots be separated as they are printed. This requirement, along with the paper quality requirement, would exclude existing DRE printer add-on technology.

The bill requires that election source code be made publicly available. In addition, audits would be required before certifying election results, with the number of ballots to be hand-counted tied to the total number of precincts and the closeness of the race. The federal government would reimburse the states for "reasonable" costs associated with implementation of the Act. To date, H.R. 811 has acquired 216 cosponsors, including Representatives Cohen, Cooper, Davis, Gordon, Tanner, and Wamp of Tennessee. This Senate companion bill is S. 559, sponsored by Senator Bill Nelson (D-FL). It currently has no cosponsors.

The Feinstein bill has very similar language requiring a voter verified paper record, though the paper version is a "record" and not the official ballot as it is in the Holt bill. The Feinstein bill gives states until 2010 to meet its standards, a move which is increasingly seen as necessary as the 2008 elections rapidly approach. There are many other differences, as both bills have many sections, but these are the key differences in their paper record requirements. The Feinstein bill does not currently have a House companion bill.

The "Count Every Vote Act of 2007" was sponsored by Representative Stephanie Tubbs Jones (D-OH) and Senator Hillary Rodham Clinton (D-NY). It has 19 cosponsors in the House and seven high-profile cosponsors in the Senate, but most of its Senate supporters (including sponsor Clinton) have since cosponsored the Feinstein bill.

The Jones/Clinton bill stands out in that it has extensive grant programs for pilot projects in states to encourage activities such as civic education in high school and same-day voter registration. It also requires and funds federal research into many aspects of elections, including ballot design, ballot chain of custody, and disability access. Finally, it would fund all of its requirements, including voting machine updates and ongoing post-election audits. This bill, however, currently has no traction in Congress.

The other bill introduced this session, the Verifying the Outcome of Tomorrow's

Elections Act of 2007 (H.R. 879), introduced by Representative Tom Feeney (R-FL), is primarily a bill requiring voters to provide photograph identification in order to vote (even by mail), but the Act does also include a requirement for a paper receipt. It also shows no movement in the House and has no Senate companion bill.

The passage of either of the two bills under serious consideration as currently written would require replacement of Tennessee's DREs, though there has been movement to amend the "Feinstein Bill" to allow DRE vendors more time to develop a printer attachment for their machines that would comply.

In addition to these VVPAT bills, two bills have been introduced to address voting by mail. The first, H.R. 1667 by Rep. Susan Davis (D-CA) and S. 979 by Senator Ron Wyden (D-OR), would help fund the switch to voting by mail as long as it followed Oregon's standards. Funding could be obtained to switch whole states, groups of counties, or individual counties to the program. $18 million would be available as the bill is currently written. The Senate bill has been cosponsored by Senator John Kerry (D-MA) and Senator Barack Obama (D-IL). The House bill has four cosponsors.

The second vote by mail bill that has been introduced in the House this session would require states to allow voters who so wished to vote by mail. Representative Susan A. Davis of California introduced the bill, the Universal Right to Vote by Mail Act of 2007 (H.R. 281), which would require that

> *(if) an individual in a State is eligible to cast a vote in an election for Federal office, the State may not impose any additional conditions or requirements on the eligibility of the individual to cast the vote in such election by mail, except to the extent that the State imposes a deadline for requesting the ballot and related voting materials from the appropriate State or local election official and for returning the ballot to the appropriate State or local election official.*

H.R. 281 does not appear to address reimbursing states for any associated implementation costs. The bill, which has 62 co-sponsors, was referred to the House Committee on House Administration on January 5, 2007. There is no Senate companion bill as yet.

Auditing Election Results

Few who advocate paper trails believe that all elections should be recounted. Most recounts are reserved for elections that are very close or that had noted irregularities. In Tennessee, even in a close election, recounts must be requested. In contrast, several states have automatic recounts when the vote is close.

Most who advocate paper trails, on the other hand, believe that all elections should be audited. Several states have audit requirements that are comprised of partial recounts of randomly-selected ballots or full recounts of randomly-selected precincts as a check against machine counts. Tennessee performs the latter type of audits only in response

to specific complaints. In addition, at least one state (Maryland) requires audits of election procedures and practices.

Testing and Auditing of Voting Equipment in Tennessee

Rules governing all aspects of election procedures are in Chapter 1360-2 of Tennessee Rules and Regulations. Tennessee has separate rules for electronic, optical scan vote counting systems, and for other types of electronic voting machines. The rules governing optical scan voting systems date back to 1986; the rules for other types of electronic voting machines were adopted the following year. Both were last revised in January 1999.[10] While neither these rules nor any other provision of state law require an audit of the results of any election, they do require that the machines, or at least a sample of them, be tested prior to their use.

Voting Machine Security

Tennessee's rules governing security of election equipment and ballots focus mainly on the process of sealing and unsealing or locking and unlocking them. Some chapters of the rules are more specific than others, and in some places, they are not clear about the number of people who must be present when seals are applied or altered or when machines or boxes are locked or unlocked. Having at least two people—two people who are acting independently of each other—present during these activities may be the best insurance we have against tampering. Where the rules are not now specific in that respect, it may be advisable to change them.

Even with proper seals and more than one person observing and transporting equipment and other voting materials, it may be possible to tamper with the electronic information that is loaded into them. VVPAT would seem to discourage tampering if the election itself were subject to testing. Malicious code that runs when certain conditions are met, sometimes called a "logic bomb," can be embedded in computer programs and has caused problems for several private sector companies. It is similar to the viruses and "worms" that travel via email. VVPAT would make it possible to detect problems such as this after votes have been tallied.

Some states and localities have included very specific "chain of custody" provisions in their election rules. These are designed to document the dates, times, and individuals who possessed or accessed voting equipment, documents, and files. Others have gone further and implemented election day tests designed to detect errors and malicious code. A limited, informal survey of Tennessee county election officials suggests that local processes may vary somewhat depending on county size, resources, and perception of risk. The metropolitan counties (Shelby, Davidson, Knox, and Hamilton) store their voting machines in a warehouse. The greater the number of machines a county has the greater the likelihood the machines are stored at an offsite facility. The larger counties with more machines generally have a third party deliver the machines to the designated polling sites. Most of the smaller counties may keep the machines in the county election commission office. Smaller counties may allow the precinct official to come check out the machines and return them when the election is over. Others have designated technicians that deliver the machines. Local officials advise us that the machines are always sealed prior to leaving the storage facility. We have no reason

based on our inquiries to believe that they are not following the state rules governing security for the election process.

Potential Improvements for Tennessee Elections

After reviewing what is known about voting machines, as well as practices in Tennessee and other states, TACIR staff suggests the following possible changes:

- ✓ **Implement voter-verified paper audit trails statewide within a reasonable time frame.** Distrust of voting systems that are entirely electronic is widespread, undermines voter confidence, and may discourage voting. The current system allows no check of the electronically-generated count other than one that uses the same machines and software to recount the same electronically recorded votes. Though recounts of DRE totals sometimes uncover votes that went uncounted for various reasons, they do not include a count that is independent of the voting machines. If something unusual happens in the election, especially if it involves some kind of equipment malfunction, voters are simply unsatisfied if there are no physical ballots to recount. Staff has concluded that, if the cost is prohibitive, it would be preferable to move slowly to replace DREs with optical scan machines rather than to consider the currently available DRE printers.

- ✓ **Adopt VVPAT that can be counted by hand, as well as by machine—machine tallies to support prompt reporting of results with hand counting for audit and recount purposes.** Not all VVPAT systems are created equal. Experience thus far with attaching printers to DREs has been unsatisfactory, mainly because of readability. Vendors are working on better systems, but they are still in the planning and experimental stages. Only precinct-level optical scan systems currently allow for verification and manual recounts and audits. Hamilton and Pickett Counties currently use optical scan systems countywide for most voters and have DREs for disabled voters. Ballot marking devices that can be used by disabled voters to mark their optical scan ballots in privacy, print them, and put them in the ballot boxes like all other voters are available.

- ✓ **Adopt a standard for VVPAT that matches that in the federal "Holt bill" and "Feinstein bill."** While staff concludes that waiting for Congressional action is not advisable, it would be unwise to ignore the standards likely to emerge if Congress passes a bill. These standards cannot currently be met by DRE printers. If such printers were purchased and Congress passed the "Holt bill" or the "Feinstein bill," the new printers would have to be discarded.

- ✓ **Require voting machine vendors to escrow all of their proprietary software so that it can be reviewed by experts as recommended by the U.S. Election Assistance Commission and secured for further analysis if vote counting problems should arise.** The inability to study the software when there are questions about the election seriously undermines confidence in the results of recounts and audits. Elections are the basis of democracy, and it is not acceptable for a private interest to shield a part of the election process from the voters they serve. Taxpayer dollars buy the voting machines and the software,

and taxpayers have the right to ensure that their investment will produce reliable results. The source code is the actual counter of votes, and that counting must be more open if the public is to accept close election outcomes. Vendors may have valid concerns about proprietary software, and those concerns should be addressed as much as practicable, but, at the very least, source code must be available for inspection by a limited number of qualified people who are not in the vendor's employ when an election is close and in question. Having a copy of the source code as delivered by the vendor would provide protection to vendors as well. In the event that the code was altered after delivery, vendors would have an official record of the code as they delivered it. A process that would allow for even more open examination of source code is desirable and should be explored for the future, even if it involves using voting machines with all open source code programs.

- ✓ **Strengthen post-election audit requirements to ensure that a minimum of machines are tested by comparing hand counts to machine totals and, if results vary by more than a small percentage, that a broader recount process follows.** As has been demonstrated time and again, any machine counter can be programmed, maliciously or negligently, to miscount. Small miscounts might not create enough suspicion to ask for a recount – especially in a statewide or national race in which individual counties do not get as much notice. But, in any size race, systematic small miscounts can change the outcome. It is a wise practice to audit everything, whether problems are suspected or not. No one would suggest that either governmental entities or corporations only be audited when problems arise.

  In most states that require these audits, a small number of precincts are randomly chosen to recount their ballots fully. Any discrepancies are investigated. If satisfactory explanations cannot be found, then all precincts will recount. Some states randomly select a percentage of ballots in all precincts and recount them manually. Any recount totals that do not fall within the statistical margin of error for the overall precinct total trigger a wider recount. As an alternative, several states also have an automatic partial or full recount only when the race was very close (generally when the top two candidates are within a point or two of each other). This saves candidates from having to appear to be sore losers by asking for a recount in a close race. The State of Minnesota enacted a post-election review law in 2004 to assess the accuracy of its voting machines. If the audit reveals a difference greater than 0.5%, a broader audit is automatically triggered.

- ✓ **Consider making early voting and voting by mail more accessible.** Broadening the availability of both would take some pressure off of polling places on election day, addressing one of the concerns of recent elections-- long lines and long waits. Furthermore, early voting has proved quite popular where it is widely available. It should be a real option for rural voters as well as for urban ones. More locations and a longer early voting period are options to consider. When voting by mail is an option, it is simply absentee voting. Tennessee

requires a reason to absentee vote. Most states do not. Allowing anyone who wishes to vote absentee would increase voting opportunity.

- ✓ **Strengthen security and pre-test requirements and make them consistent for all voting systems.** The rules that govern election procedure appear to have been updated hastily to include new technology. There are some inconsistencies in the testing requirements for different types of technology, and there is much that is out-of-date and no longer applies. While this is not necessarily critical to fair elections, it does need to be done at some point. And outdated rules could prove embarrassing if Tennessee should become the center of national attention in any election.

- ✓ **Consider a Vote by Mail pilot program that would allow the state to assess the advantages and disadvantages of this type of voting in Tennessee.** States that use this are so excited about it that it seems worth trying. There are certainly potential problems, and it may not be for every state, but potential benefits include decreased expenses and higher turnout. A pilot program is the perfect way to find out if it works for Tennessee. The Joint Study Committee on the Voter Confidence Act of 2006 recommended a pilot program, and a bill currently in Congress would fund such a program if it passes.

- ✓ **Consider election day parallel voting machine tests to detect hidden programs that are triggered by election day conditions and are erased so that they cannot be detected later.** In this test, a voting machine in each precinct is chosen randomly to be removed from use and put on public display. Periodically, a ballot is run through it and its totals are checked to make sure it counted the ballot correctly. This would be a good measure to check election day performance of the machines and ensure they do not have hidden programs that will cause miscounts and that activate only on election day. The State of Maryland used this process in 2004, casting 1,300 ballots to test the reliability of their machines. If optical scan were to be adopted statewide, most counties would have only one counting machine per precinct. Parallel tests could still randomly select at least one machine per county to test openly on election day.

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[1] Zogby International 2006.
[2] National Association of Secretaries of State 2004.
[3] See, for instance, Myerson 2005 and McCloy 2005.
[4] McCloy 2005.
[5] Moore 2006.
[6] See a full list of early and absentee voting laws by state at http://electionline.org/Default.aspx?tabid=474
[7] See 17 USCA § 101, *SecureInfo Corp. v. Telos Corp* 387 F. Supp. 2d 593 (E.D. Va. 2005) and TCA Title 47, Chapter 25, Part 17.
[8] Commission on Election Reform 2005, 29.
[9] Wagner, David, 11.
[10] Rules of the Tennessee Department of State Chapters, 1360-2-12 and 1360-2-13.