H.B. 5492 – Oppose without significant changes

Government Administration and Elections Committee
Testimony – March 10, 2014

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Chairs and members of the Committee, my name is Luther Weeks, a Certified Moderator and a Computer Scientist. Most of my career focused on developing software, evaluating software products, and recommending technology strategy for the Travelers, in its Computer Science Division. I also spent nine years developing and marketing software products in small companies, for use in large organizations.

I have personally observed over 80 post-election audits in Connecticut municipalities. In 2008 I contributed to the *Principles and Best Practices for Post-Election Audits,* endorsed by several good government groups.
http://www.electionaudits.org/principles

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I oppose H.B. 5492 as proposed, a demonstration of electronic audits. I have long been a strong proponent of machine assisted audits, in Connecticut and nationally. Unfortunately, as written, I am concerned that it might be an unsatisfactory and redundant project – theater, not integrity – possibly delaying or precluding effective use of such technology in Connecticut. Possibly leading to what some would call a "pretend audit".

Post-election audits are different than other audits for several reasons:

- **Unlike other audits they are not independent. They are conducted by the same officials who are responsible for conducting the elections, specify the election equipment, and select vendors to program them.**
- **Unlike financial audits, such as bank audits or campaign finance audits, because of the secret vote, there are no independent records similar to bank statements which can be compared with other financial records of the entity being audited. Election audits must be compared against the paper ballots held by election officials.**
- **Thus, audits and recounts must be conducted publicly and transparently, providing for public verification. Without that they cannot be trusted. Without that they cannot provide credibility for our elections, that is, credibility for our democracy.**

Concerns with this bill – Safguards and Requirements Missing

My concerns with this bill is not what it says, but what it does not say or include. Perhaps my skepticism is unjustified, yet that should not preclude requiring in the law what should actually be part of the project to make it effective.

Detailed concers and proposed changes in the law to address them:

- **The pilots should be required to be noticed and performed in public view**
  - Public money is being spent on the pilot
  - Previous demonstrations, very similar to this pilot barred the public from observation

- **The pilot should be required to demonstrate the equivalence of the current law, in public transparency and public verification**
  - A report by the SOTS Office and Uconn on the previous demonstrations of the system and other public information I have obtained, demonstrate only that the system and procedures used in those demonstrations did not and could not provide public verification, even if they were open to public observation. http://voter.engr.uconn.edu/voter/wp-content/uploads/AS-2013.pdf
  - The law should require transparency, a demonstration and proof of public verification.
  - The project and report should allow for public comments
  - I recommend a Technical Focus Group, independently moderated and formed. This was a small part of the evaluation of voting equipment by the Bysiewicz Administration, which contributed directly to our selection of optical scan equipment over touch screens. (Providing integrity, and saving the state and municipalities millions)

- **Any pilot should require independent evaluation. Unlike, evaluating voting machines, Internet voting, or electronic check-in equipment by the SOTS and Uconn, this pilot is more a repeat demonstration of what the SOTS Office and Uconn have developed.**
  - It is difficult for officials to conduct an audit of elections that they are responsible for, Similarly, it is difficult for officials and technologists to evaluate their own technology.
  - At minimum it provides the appearance of bias and a lack of credibility
  - This pilot evaluates only one system. There are other systems available which should be considered for comparison. A university developed open-source system also available at low or no cost to Connecticut. At least one professionally developed and documented system available for purchase that has been used in pilots in several states, including CA, FL, CO, and NY.

- **A pilot system should not be substituted for the current required manual audit.**
  - The pilot requirements do not meet the requirements of the current audit, for transparency, and public accountability.
  - It would be logistically challenging to accomplish the project to substitute in three towns for the current audit.
    1. The three selected towns would have to be chosen after the audit drawing, then approved by the town bodies, in time for the pilot to be accomplished during the legal audit period.
    2. Otherwise, the pilot towns could be selected over a period of months
    3. The pilot audits could be performed over a period of months

Three leading scientists, in the field of Post-Election Auditing have provided us with some guidance and requirements for *machine assisted manual post-election audits*. Their pre-publication papers are attached my testimony today.

While academic experts focus on accomplishing *risk-limiting audits* with machine assistance, Connecticut law, as most state audit laws, performs the easier to define, simpler to accomplish, more expensive, and less useful, *fixed percentage audits*.

Translating their risk-limiting requirements for machine assisted audits into a process for machine assisted fixed percentage audits, **I propose the following, as providing equivalent public verification to Connecticut's current manual audit law**. I have reviewed the process with a recognized academic expert on election auditing, Dr. Alexander Shvartsman, of Uconn. Such a process or similar process should be demonstrated and independently evaluated in any pilot:

> *The audit may consist of the retabulation of all the paper ballots by means of an independent tabulation process using hardware and software approved by the Secretary of the State, with officials following procedures established by the Secretary of the State, established prior to the election or primary, retabulating all contests in the election or primary. Such tabulation shall produce a cast vote record for each ballot recording each vote assigned by the retabulation on each ballot, with a means of associating the ballot with the cast vote record by the sequence in which the ballot was scanned or by a unique identifier added to each ballot. Such retabulation shall result in the export of all cast vote records, made available for review and in a standard computer readable form for public observers present at the audit and later transmitted in such electronic form to the Secretary of the State. Immediately following such export and cast vote record availability, as part of the audit counting session, the registrars of voters shall conduct a random manual audit of the retabulation, by randomly selecting original ballots and comparing the manual interpretation of the marks on the ballots to the associated cast vote records, recording for each ballot selected any differences between the retabulation cast vote record and the manual interpretation of the ballot, recording circumstances, if any, that might account for such difference, such as an inaccurately completed ballot. The number of ballots randomly selected for the manual audit shall be twenty (20) plus two (2) percent, up to a maximum of sixty (60), of the ballots retabulated for all districts audited in the municipality in the counting session. The results of the tabulation shall be reported on a form prescribed by the Secretary of the State which shall include the total number of ballots counted, the total votes received by each candidate and position in questions on the ballot including a printed record from the retabulation machine, along with a copy of the original election or primary tabulator tape, and a record of the manual comparison of randomly selected ballots, noting any differences between the retabulation interpretations and the manual interpretations.*

Additional information relevant to H.B. 5492

Two pre-publication papers provided by three leading experts in the field of post-election auditing, articulating why re-tabulation by a second machine is an inadequate substitute for a manual audit. They also explain an alternative, efficient "Machine Assisted Audit" alternative:

- **Professor Philip B. Stark, Chair, Department of Statistics, U.C. Berkley** http://statistics.berkeley.edu/~stark/
- **Professor Ronald L. Rivest, Department of Computer Science, MIT, and Turing Award Recipient** http://people.csail.mit.edu/rivest/bio.html
- **Professor Mark Lindeman, Political Scientist, Adjunct Columbia University** http://www.columbia.edu/cu/bulletin/uwb/subj/POLS/W4911-20131-001/

Thank You

statistics.berkeley.edu/~stark/Preprints/retabNotAudit13.pdf

Machine Retabulation is not Auditing

Mark Lindeman, Ronald L. Rivest*, and Philip B. Stark

24 March 2013

- A **post-election vote tabulation audit** checks election results by manually inspecting some voter-verified records (usually paper ballots). A well-designed audit can produce strong evidence that election outcomes are correct—and can correct incorrect outcomes.

- The principle of **evidence-based elections** says that an election should provide convincing evidence that election outcomes are correct. True audits allow observers to see directly how well the voting system performed, which can provide such evidence.

- Some claim that election results can be checked by **machine retabulation,** in which ballots are rescanned on other equipment. Machine retabulation may happen to catch some errors, but it is not really an audit. Machine retabulation relies on the false assumption that two machines can't *both* be wrong.

- Some claim that retabulation adequately checks the voting system because it is "independent" of the voting system. But a retabulation system could be misconfigured in the same way as the voting system, could misinterpret some ballots in the same way, or could be subverted to cause it to report the same incorrect results. Two unaudited machine counts are not necessarily better than one.

- Some claim that retabulation can adequately check the voting system results provided that the two sets of vote counts match in sufficient detail. This is like claiming that if two expense reports list the same expenses, both must be right and there is no reason to look at any receipts.

- Some claim that retabulation itself can be "audited" by comparing ballot images produced by the retabulation system with the system's interpretation of those images. At best, this tests internal consistency: whether two parts of the retabulation system agree with each other. It does not test whether the system correctly interpreted the ballots. At worst, a subverted retabulation system could pass this test, yet misreport *every* vote. This is not an audit. It cannot confirm that the election outcome is correct.

- A well-designed retabulation system can help in a **machine-assisted audit.** In a machine-assisted audit, the retabulation system produces an interpretation of votes on each ballot (a Cast Vote Record, or CVR) that can be matched with that ballot. The CVRs are exported from the retabulation system. Observers verify that these exported CVRs produce the same electoral outcome (winners, etc.) as the voting system. Then observers compare a random sample of actual ballots against the corresponding CVRs. *This comparison is between actual ballots and CVRs, not between digital images of ballots and CVRs.* A machine-assisted audit can produce strong evidence that election outcomes are correct. Retabulation cannot, even if the CVRs are checked against the digital images of the ballots.

- There is currently no way to audit votes cast online, and there is little prospect for the foreseeable future. Despite claims about "military grade encryption," Internet voting does not create a durable, voter-verifiable record against which the results can be checked. While votes cast on the Internet could be retabulated, they cannot be audited. Both NIST and the Department of Homeland Security agree that secure online voting does not currently exist, and—if it is possible at all—is a long way off.

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statistics.berkeley.edu/~stark/Preprints/retabulation13.htm

Retabulations, Machine-Assisted Audits, and Election Verification

by Mark Lindeman, Ronald L. Rivest, and Philip B. Stark. 20 March 2013

Introduction

In a **machine retabulation** (hereafter just "retabulation"), ballots cast in an election are rescanned and reinterpreted to produce new vote counts. A retabulation may be complete (all ballots are rescanned) or partial (e.g., ballots in some election districts or precincts are rescanned). Some retabulations produce records of the votes purportedly cast on each ballot: Cast Vote Records, or CVRs.

Some jurisdictions around the country use retabulations in lieu of manual recounts. Other jurisdiction are considering machine retabulations as a routine method of checking voting system results. For instance, Connecticut currently requires a manual post-election audit, in which votes cast in several contests in at least 10% of election districts statewide are counted by hand, but it is considering legislation to replace the manual audit with a retabulation.

Reliance upon a machine retabulation violates best practices for post-election audits. It even violates the common definition of a post-election audit, which entails **manually inspecting** some ballots (or voter-verified paper audit records). A manual audit provides a human-observable check on the vote tabulation that does not depend upon the trustworthiness of any hardware or software component.

Machine-assisted audits (Calandrino et al., 2007) that combine retabulations with manual audits, if properly designed, have real advantages over both unaudited retabulations and hand counts of entire precincts or other large "batches" of ballots. As we explain further below, a machine-assisted audit crucially entails manually comparing a random sample of ballots with the machine interpretation of each ballot. Relying on unaudited retabulations is dangerous and unwarranted.

Software independence and retabulations

A voting system is **software-independent** if an undetected change or error in its software cannot cause an undetectable change or error in an election outcome (the winner[s], or whether a runoff is needed). ("Software independence" was initially defined in Rivest and Wack, 2006; Rivest, 2008.) Software independence implies that people do not have to trust that the voting system tabulated votes as it should: At least some people can observe whether it did. Auditing methods should be designed to leverage software independence, by verifying the voting system's performance without relying upon the correctness of its software.

A machine retabulation system without a manual audit squanders the benefit of software independence. Instead of demanding trust without evidence that the voting system performed correctly, it demands the same unsupported trust of the retabulation system. Such a system constitutes poor IT design and poor public policy. Relying on unaudited retabulations is like insisting that because two computerized expense reports agree, there is no reason to check the receipts.

Retabulation can detect some kinds of voting system errors, in some circumstances. If the retabulation results differ materially from the voting system results, then at least one set of results must be wrong, and an audit or hand count can reveal which one(s). A retabulation may detect certain inadvertent errors such as double-scanning some ballots, or some configuration errors.

However, even a close correspondence between two sets of machine counts cannot demonstrate their accuracy—no matter how "independent" the counts are said to be. Similar systems are subject to making similar errors. Even apparently dissimilar systems may have similar software defects, or may misinterpret certain kinds of ballots in the same way, or may be subject to subversion that causes them to report the same incorrect results. The purpose of auditing a machine system—whether it is the voting system or a retabulation system—is to determine the system's accuracy through observation, rather than depending upon assumption or speculation.

Wishful claims for retabulations

Two other misconceptions about retabulations deserve special mention.

One misconception is that if a retabulation system produces sufficiently many subtotals that match (or almost match) the corresponding voting system subtotals, the accuracy of both systems is demonstrated. This approach is somewhat like asserting that we really can verify a computerized expense report by comparing it to another computerized expense report, without checking the receipts, as long as the expense reports match in sufficient detail. In reality, what matters is not how detailed the expense reports are, but whether the reported details stand up against the receipts.

Another misconception is that we can "audit" the retabulation system by checking graphic ballot images stored in the retabulation system against the ballot interpretations (Cast Vote Records) produced by—and, in some cases, stored in—the retabulation system. At best, this process checks the internal consistency of the retabulation system—or part of the retabulation system. At worst, a subverted retabulation system could display arbitrarily many ballot images and correct interpretations thereof, yet *every* vote count could be misreported. Observers should be able to assess the retabulation system's accuracy without relying on the system itself.

Comparing images of ballots to Cast Vote Records cannot provide much evidence that electoral outcomes are correct. To know that outcomes are correct, we must know that the combined error rate of creating the graphic images from the ballots of and converting those images to Cast Vote Records is small. But comparing images to Cast Vote Records checks only the latter: it gives no information about the first rate. Therefore, it cannot confirm that electoral outcomes are correct.

The easiest way to tell whether the combined error rate is small is to measure the paper-to-Cast-Vote-Record error rate directly: to manually compare the original ballots to the Cast Vote Records.

Evidence-based elections and retabulations

Ideally, an election does not merely report results. Rather, it should provide convincing evidence that the reported results are correct. This principle is called *evidence-based elections*. (Stark and Wagner, 2012.) Retabulations cannot provide convincing evidence that outcomes are correct, because they do not examine the ballots, the artifact that the voters themselves had the opportunity to verify correctly reflected their intent. By failing to leverage the Software Independence conferred by voter-verifiable physical ballots, retabulations at best provide negative evidence: they can detect some "smoking guns," but cannot provide affirmative evidence that electoral outcomes are correct. Absence of evidence is not evidence of absence.

Machine-Assisted Audits

Audits that compare individual ballots to the voting system's interpretations of those ballots (Cast Vote Records, or CVRs) can be far more efficient than audits that hand-count all ballots in selected precincts or other batches. However, these **ballot-level comparison audits** are intractable on many voting systems,

which either do not record CVRs or do not permit matching each CVR to the corresponding ballot. Therefore, **machine-assisted audits** based on a retabulation may provide more rigorous audits with less effort than alternative approaches. (Machine-assisted audits were first described in Calandrino et al., 2007.)

A machine-assisted audit, also known as a transitive audit, follows these basic steps:

- All the ballots are reinterpreted by a retabulation system that supports ballot-level auditing. For instance, the system may produce CVRs in the same order as they are rescanned, so, say, the 34th ballot corresponds to the 34th CVR. It may even stamp an identifying number on each ballot before or after the ballot is rescanned.
- If the retabulation system does not produce the same election outcome (e.g., winners) as the official voting system, the audit cannot proceed; a full hand count should be conducted to resolve the discrepancy.
- If the retabulation system does produce the same outcome as the official system, then the retabulation system is audited. First, the CVRs produced by the retabulation system are **committed to**: exported in some manner that allows observers to confirm that they are not altered at any point during the audit. The exported CVRs are retallied, using one or more methods independent of the retabulation system, so that observers can confirm that the CVRs correspond with the vote totals produced by the retabulation system.
- Ballots are randomly sampled, and each ballot in the sample is manually compared with the corresponding retabulation CVR. (The number of ballots sampled depends on the audit method, on the desired level of confidence in the electoral outcome, and, generally, on the results of the comparisons.)
- If the audit produces strong evidence that the retabulation system reported the correct outcome, then it likewise provides strong evidence that the official system was correct, since the two reported the same outcome.

In particular, if the audit of the retabulation system is a risk-limiting audit, then this approach provides a risk-limiting audit of the original system. A risk-limiting audit has a large, predetermined minimum chance of leading to a full hand count if a full hand count would report a different outcome than the system being audited. For a further discussion of risk-limiting audits in general and machine-assisted (transitive) audits in particular, see Bretschneider et al., 2012.

Crucially, a machine-assisted audit does not rely upon the accuracy of the retabulation, but rather verifies it, in two steps: (1) Confirm that the CVRs produce the totals reported by the retabulation; (2) Manually confirm a high degree of correspondence between the CVRs and the corresponding ballots. Additional procedures may be implemented to provide insight into the performance of the voting system and/or the retabulation system.

It is also possible to perform a *partial* retabulation combined with a manual audit of that partial retabulation. If the manual audit is large enough, this approach can be almost as effective as a hand count of the retabulated ballots. How this approach compares to a comprehensive machine-assisted audit depends on the breadth of the partial retabulation, but in general it cannot provide as much evidence that electoral outcomes are correct.

Typically, most of the time and effort of a machine-assisted audit is in the initial retabulation: re-scanning the ballots, creating Cast Vote Records, and computing contest results from the Cast Vote Records. Manually comparing a relatively small number of those ballots to the corresponding CVRs is, in comparison, a modest task, which can be observed by many people, and can be tailored to meet constraints of time and budget. If a retabulation system supports ballot-level manual auditing, skipping this manual verification step makes little sense, since it takes little additional work to produce much

stronger evidence that the retabulation is correct. If the system does not support ballot-level manual auditing, we would advise against adopting it.

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