Electronic Ballot Counting Device Advisory Committee
Meeting Minutes of October 30, 2009 at 1:00 PM
71 South Fruit Street, Concord, NH, HAVA Conference Room

Attendance:
Thomas Manning, Assistant Secretary of State and Temporary Chair
Representative Richard Drisko
Representative Suzanne Harvey
Representative Robert Perry
Anthony Stevens, Assistant Secretary of State

Secretary of State Staff:
William Gardner, Secretary of State
David Scanlan, Deputy Secretary of State
Daniel Cloutier, Assistant Secretary of State

Guests:
Dr. Andrew Appel, Chair, Princeton University Computer Science Department

Also Present:
Mr. & Mrs. Appel
Melissa Bernardin
Rep. Tim Horrigan

I. Call to Order

Mr. Manning, Assistant Secretary of State and Temporary Chair, called the meeting to order at 1:00 PM. Mr. Manning noted there was not an official quorum.

II. Meeting Business

Mr. Manning gave the floor to Secretary Gardner, who introduced Dr. Andrew Appel.

Secretary Gardner welcomed Dr. Appel and thanked him for his efforts in helping the nation achieve a higher level of security in its elections. His efforts are in tandem with what the Committee has been working on. Secretary Gardner thanked Rep. Perry and Mr. Stevens for their assistance in getting Dr. Appel to appear before the Committee. Secretary Gardner noted that there are only a few people in the country with his background and experience. He expressed his gratitude to Dr. Appel for coming and sharing his knowledge on the subject, and acknowledged Dr. Appel's parents, Mr. and Mrs. Appel, who are residents of New Hampshire.

Secretary Gardner introduced the 3 members of the House of Representatives who are currently serving on the committee; Rep. Perry and Rep. Drisko, who were instrumental in getting the Committee established and Rep. Harvey who is the Vice Chair of the House Science, Technology and Energy Committee. Secretary Gardner noted that Rep. Perry is an experienced member of the Election Law Committee and that people look to him on this subject. Secretary Gardner also introduced Durham Rep. Tim Horrigan, who serves on the House Election Law Committee.

Dr. Appel began by explaining that he had taken a look at a draft of the Committee's report and felt that the Committee had identified most of the issues. He explained that his research focused on how to improve voting machine software, which relates to his research concentration in computer security. He said that he had identified the following two issues in NH in his conversations with Mr. Gardner and Mr. Stevens in a conference last August:

1) How could the state adopt random audits of optical scanned ballots in an efficient and cost-effective way?

2) How could the state design secure computerized voting machines from the computer scientist's point of view?

Dr. Appel gave an illustrated presentation on the history of voting in the United States from the mid 19th century to 1980. He opined that when the precinct count optical scanning machines were introduced in 1975, their use meant less opportunity for inappropriate handling or manipulation. The voter put their ballot into the machine and there was little worry about chain of custody. If the machine failed, officials could count by hand. It was a very robust process. In 1980, the DRE (Direct Recording Electronic) was introduced. DREs introduced an inherently weaker process since they had no paper trail.

"What do computer scientists think of this?" he asked. He mentioned Stanford Professor David Dill and his organization "Verified Voting.org." Prof. Dill says there is just no way to guarantee against cheating in the computer programs used in the machines. You never know if the correct computer program is actually installed in the machine or not. This also applies to optical scanning machines, he said.

Dr. Appel pointed out that the answer to security concerns is not hand counted paper ballots, as that process could be tedious and error prone and there are still ways to tamper with hand counted paper ballot results.

Dr. Appel stated the problem is that the program that controls the operation of the machine is stored in the machine's own memory, along with the data on which it operates. Thus it is a general purpose computer and the program can be easily modified. In 1952, the computer program itself was in the stored program. An example of a stored-program computer today is the cell phone.

It would be possible to make a machine cheat by writing a computer program so that, on election day, between 10 AM and 5 PM, it cheats by adding votes to the wrong column. The voter would not see anything amiss. It will not cheat on non-election days and/or during pre-election accuracy testing. The software program could be loaded into the voting machine at the factory or in the field.

Dr. Appel stated that the faculty at the University of Connecticut (UConn) are the people to talk to about the Premier election management system (GEMS) and yes, the state would need a letter from Premier/ES&S to satisfy the Connecticut people. The UConn,faculty could tell you about the GEMS software capabilities.

Rep. Perry asked about the crop scanner, a device that can be used to read Accuvote memory cards. Mr. Cloutier indicated that the state has obtained a crop scanner and, in a test run, it took 50 – 59 minutes to download a single Accuvote memory card with it. He feels it is antiquated software and takes too much time to be functional for efficient memory card review. He noted that crop scanners are not cheap or plentiful; he was able to find only one after quick search. Dr. Appel commented that if there was only one crop scanner left, that could be a problem.

Dr. Appel spoke further about the Sequoia memory cartridges that he had encountered in New Jersey, including the proprietary reader and writer. He noted that, in the State of California, they asked computer engineers to make a device to read and write to the Sequioa and they had succeeded. You just have to get someone to do it.

Dr. Appel was asked whether a voting machine could be developed in which the software could not be replaced. Dr. Appel said it was not practical. He said whoever installs that software could potentially have control over the election, so you would need to trust the installer.

Dr. Appel was also asked whether one can inspect the software and hardware that is in the machine with confidence. Could one take a third party device and somehow plug it into the computer and trust the hardware path of the computer to get to the chip that counts the votes? Dr. Appel said that the consensus view is that this cannot be achieved in a perfect or sufficient manner, since it can be hard to understand and track the routing of electrical currents.

Dr Appel's recommendation was:

- The optical scanning approach is his preferred method.
    - It relies on a voter verified paper ballot.
    - It is currently the best and most reliable protocol.
    - The computer can be checked from end to end by counting the paper ballots.

- Random Audits
    - A recount of a random sample of precincts
    - Recounting one or two precincts could determine if counts agreed with computer.

Dr. Appel explained "Random Audits as Applied to NH"

- Voters cast their ballots that are initially counted using an optical scanning tabulator
- Select small percentage of precincts to audit
- Recount by hand the optical scanned ballots in those precincts
- The audit must be done publicly and transparently
- Any significant discrepancy may mean that the machines malfunctioned or cheated
- A discrepancy gives reason to suspect fraud and a need to widen the recount.
- No discrepancy equals confidence in the computer tabulated result
- Precincts are assumed to be small and all the same size. This does not work well in New Hampshire, because of the wide range of medium to very large voter precincts that exist in the state.

Dr. Appel's solution to address New Hampshire's diverse precinct sizes:

- Count the whole town with one optical scanning machine, as is done now
- Divide large precincts into many small virtual precincts
- Establish one virtual precinct for each 200 voters
- The optical scanning machine can print sub-totals for each virtual precinct
- Ballots have different precinct numbers in lots of 200
    - Every 200 ballots has a different precinct number
    - Voters and election officials may see a precinct number on the ballot

    - There is no other visible difference in the ballot from the voter's or poll worker's point of view.
- Random precinct audit scenario
    - One polling place could have 40 precincts
    - Randomly select two or three precincts out of all of these precincts
    - Two Step Process
        - Open up the ballot box, look for and remove the selected precinct's ballots with the same precinct number. (It may be easier to organize the election so that a precinct's ballots go into one box (or a small number of boxes.)
        - Recount by hand the races on that precinct's ballots. It may be only 200 ballots or so, if you keep the precincts small.
- In-house Ballot Preparation & Programming
    - Software implementation may cost 6 or 7 figures (or perhaps less)
    - The Diebold GEMS system probably already enables multiple precincts per voting machine in a manner that would satisfy the above audit protocol
    - Possibly share some costs with other states
- Need a law to do random audits
    - Currently approximately 23 states have random audit laws.

How well is NH doing?

- NH's protocol is there already, as it relies on precinct count optical scanning machines. This is very good.
- NH is well respected with regard to running elections cleanly.
- You should have random audits as a state law, because you can't really trust those scanners. Several states require random audits already, but NH does not. Frequent recounts are not really a substitute.

Mr. Manning asked for questions.

Rep. Perry thanked Dr. Appel for answering some of his major questions. He said we had heard from other experts that the use of the precinct count optical scan tabulating machine with random audits is the best route to take. Rep. Perry explained that a recount audit bill was attempted last year and it had failed. He hopes with the Committee report, the Ballot Law Commission will embrace the recommended solutions and have a new understanding of the subject, with a focus on clean elections as a goal. If he is reelected, he wants to bring back HB186, his audit bill which failed in 2008. Rep. Harvey said she believes it is not too late; he could still go to the House Rules Committee to get the bill considered in 2010.

Discussion followed as to whether NH's current recounts fulfill the goals of a random audit. Dr. Appel felt that they did not. He explained if you consistently have recounts for the same offices, e.g. senate, representative, sheriff, city council etc., the cheaters would know which races to stay away from, or they already know the percentage margin to exceed in order to avoid a recount. The cheaters could then ensure their candidate wins by a respectable margin, enough to avoid a recount.

Secretary Gardner pointed out that in state recounts, candidates can gain 3 or 4 votes because voters mark their ballot in a manner that the machine does not catch. In other words, the

machine does not always capture the intent of the voter. The candidates are present and see these changes. If the candidates know about that type of potential change in results, the public may also think we should recount more towns. Secretary Gardner wanted to know whether the actual official results would change as a result of an audit.

Dr. Appel stated that there are two things the machine can do wrong: 1) deliberately cheat or 2) incorrectly read the will of the voter, which does not imply cheating. In a recount, a goal is to correctly interpret the will of the voter. If the machines are consistently getting it wrong, you may need better machines to read the ballots accurately. Dr. Appel noted that in the recount of Minnesota's U.S. Senate race, the machines proved to be extremely accurate in reading the will of the voter. You need different standards in audits than in recounts, he said.

There was a question about releasing the audit numbers. Dr. Appel stated that election officials should independently release the election results as soon as they are available, from the optical scanner and separately from the random audit. One must then ask, if a discrepancy discovered in an audit were extrapolated to all aspects of the election, would it have changed the outcome of any race?

Mr. Stevens asked how many precincts should be counted in an audit. Dr. Appel replied it could be 2% or less, using the above method. He stated it is not that hard to pull the random precinct ballots out from among the rest of the ballots. As the ballots fall into the hopper, they fall on top of one another. The moderator will have already printed out the subtotals of the precincts and will have made public the totals on the printed receipt, so there is an independent record.

Mr. Appel asked how hard is it to have a piece of hardware that would look for those precinct's ballots. Dr. Appel replied that then you would be trusting one machine to trust the other machine.

Mrs. Appel wanted to know how scientists and statisticians came up with this 2% threshold. Dr. Appel said it arose because legislatures need to know what threshold they should establish in a random audit law. In general, the more small precincts you have, then the smaller number of ballots you would need to recount and the easier the job.

Dr. Appel offered two similar concepts to envision. If he had a jar with one hundred marbles, ten colored blue to represent cheating and ninety colored white to represent honest counting, would a small random sampling of two of those marbles produce a blue marble? It probably would not. On the other hand, if he had a jar of sand containing 1 million blue grains of sand (to represent cheating), thoroughly mixed with 9 million white grains of sand (to represent an honest count), would a small random sampling produce any blue grains of sand? Absolutely, he said. Thus the argument in favor of a small random sampling of large numbers of ballots.

Mrs. Appel wanted to know, in the states with random audit laws, do they have additional laws to follow up if the random audits show clear cheating or detect a problem? Dr. Appel said, if you have a random audit law, you need a clear procedure stating what you are going to do if you discover an anomaly. You must have a clear law to either recount or expand the process in such a circumstance.

Rep. Harvey wanted to know if you could connect the dots between random audits and the vote tabulating machines. Dr. Appel drew the Committee's attention to the period after the ballots are

dropped into the box, the polls close, and the machine tape is printed and before the machine cartridge arrives in some central tabulating facility. During this period, these cartridges (or memory cards) may be insecure. It is not difficult for someone to change the votes in them, but this is also after the time the machine tape should have been printed and made public. The totals should be initially published at the local polling place or precinct. If there was any tampering after the first machine tape was printed, the public could compare the machine (cash register) tape printed at the poll closing, then any tampering would become evident using this approach. Using this method, tampering would be regrettable but not fatal, because you can catch it.

Dr. Appel's main concern is from the time the voter marks the ballot and drops it into the machine. If the software is cheating and lies on the ballot tape, the only way to detect it is in the pile of voted ballots. They can be audited in separate ways and this can be done by the public.

Dr. Appel listed the different state approaches to designing a random audit law:

- Some states recount with a predicted certain percentage formula established by a:
    - Statistician
    - Computer science expert
    - Election expert in your state
    - In NJ, the Secretary of State appoints the experts who designate the formula
- Design a formula and imbed it into the law
- He suggests not doing a parallel count on Election Night. That keeps the Moderator out of it.
- It is better to do the audit starting on the day after election day, relying on a public random drawing
    - Do not do the selection earlier than the election, since it lends itself to cheating
- Try to get the audit done within the week, as West Virginia does
- The audit must be public and transparent

Mr. Manning called for a 10 minute break at 2:35 PM. During the break, Secretary Gardner displayed 1892 New Hampshire ballots from the Division of Archives and Records.

Mr. Manning called the meeting back to order at 2:45 PM.

Mr. Stevens mentioned that he had provided Dr. Appel a copy of the draft of the Committee's final report. Toward the end of the report it addresses the question about whether or not to upgrade the Accuvote firmware chip. Mr. Stevens indicated that we have the option to upgrade to the Accuvote 1.96.13 chip and GEMS 1.21.5. He explained that in 2006, the California Secretary of State's Voting Systems Technology Advisory Board (VSTAAB) identified 16 vulnerabilities in the Accuvote Version 1.96 chip. In 2007, the California Secretary of State followed up with the Top-To-Bottom Review (TTBR) of all voting systems in the state.

Dr. Appel said he had looked at California's VSTAAB report very briefly. He stated that the VSTAAB report states clearly what is needed in each area of vulnerability. He thinks any Premier/Diebold engineer could have fixed these vulnerabilities quickly. The report is straight forward reading, he said. If he really wanted an answer concerning whether it had been done, he said he would give a copy of the source code, under a non-disclosure agreement, to someone like VSTAAB co-author University of California - Berkeley Professor David Wagner and ask him whether the fixes had been made.

Mr. Appel said that one would assume that a state could estimate the cost of a recount and the cost of an audit. The Legislature could be provided with an estimate of the costs of each option. Mr. Manning observed that the Committee has not delved into audit mechanics with specificity, making it difficult to cost that option precisely. Rep. Drisko agreed we would need to estimate the cost of an audit. Mr. Stevens said once one has identified the specifics, it is fairly simple to estimate the cost range of a recount or an audit.

Secretary Gardner mentioned his meeting with Harri Hursti last summer, and recalled his discussion about the Accuvote (version 1.94) that Hursti had hacked in Leon County, Florida, after being given access to the machine. At the time, Mr. Hursti had told him that, if he were New Hampshire, he would continue to use the Accuvote machine for the state's elections. Dr. Appel said if the approach were to keep the machines, these machines are easy to hack, but the upgrades would make it harder to hack. You will never make the Accuvote machines perfect or unhackable, he said. As a result, you should conduct audits, he said.

Rep. Perry suggested then, even without the random audit law, we should have the chip replaced and address the 16 vulnerabilities. Dr. Appel responded that either way the upgrade should make the chip more secure. He suggested that we call around to other states and see if the newer version of the Accuvote works. Mr. Cloutier said a chip upgrade addressing the 16 security issues would leave less vulnerability. Dr. Appel said the state should ask the vendor whether the 16 vulnerabilities have been fixed.

The discussion continued about the industry trend toward further disclosure of source code. Dr. Appel observed that, concerning the machine itself and the ballot software, possibly there has not been enough competition in the business world. There is the question of communication between the machine and the election management system. The different optical scanning machines with different vendors are a good thing, in that states are less likely get locked into one system. States can and should make demands for better election management systems. The disclosure of source code is, in general, is a good thing. It enables the public, scientists and computer engineers to look at source code and see for themselves if it is working. Very often, he said, what gets left out of the discussion is the computer software that uploads the firmware. It doesn't occur to most people to look at this software, he said.

Rep. Drisko said he was concerned about software in the (Accuvote) memory cards. He thought Diebold's (Premier's) reputation is slowly deteriorating. Dr. Appel said Accuvote OS cards are vulnerable. These (recommendations in the EBCDAC report) would make it less vulnerable, he said, so we should pursue them, especially if it costs only $75.00 a machine to upgrade. "I don't think anyone is telling you to throw out the (Accuvote) machines," he said.

Rep. Perry mentioned a YouTube Video about an Ohio precinct in which the election results were transmitted electronically to a central tabulator but did not get there directly. First, it went to (man-in-the-middle) location, where the risk of tampering was high. Dr. Appel responded that people have worked hard in Ohio to clean things up. In New Hampshire, he said, you take it for granted that the local polling place's machine tape printed out election results, but, without a law requiring it, the general public may not get to see the polling place results before they go to a central tabulator. New Hampshire is not faced with this procedural weakness, he said.

Mr. Stevens asked Dr. Appel if he could estimate the number of lines of code in a typical tabulator. Dr. Appel responded that the figure might be in the neighborhood of 100,000 lines, which is quite a lot to review. Mr. Stevens asked if Dr. Appel had a class of computer science students, how long would it take an adversarial team to review this number of lines if the code were in a well-structured modern format? Dr. Appel said he did not know the answer. He said that software engineers would be better at estimating this than he; 100,000 lines of code represents a moderate level of software complexity. If you want safeguards for voting machines, he emphasized, you must print out the polling place totals and publish them, he said. Then anyone in the general public can compare the polling place totals with the central tabulation totals. Such a transparent process is good and provides great comfort. If there is no paper, he said, it is not good.

Mr. Stevens acknowledged that Dr. Appel and Prof. Felton had hacked DREs at Princeton. He asked whether Dr. Appel had confidence he could hack almost anything. Dr. Appel said he and his students had hacked a Diebold DRE and a Sequoia Advantage DRE. The mechanisms are both different in each machine. In the Diebold DRE, new firmware was downloaded in the machine. In the Sequoia DRE, the software is in a CD Rom, and one needs a screwdriver to pull the existing one out and push another one in. First, he needed to understand how to pick a lock. He can now pick a lock on a Sequoia machine in 10 seconds. Dr. Appel was asked whether he could replace seals on a voting machine without leaving much evidence. He stated he recently did so in court in front of the judge. (This argues in favor of more tamper-evident seals for the machines.)

Rep. Perry asked the following questions: "Are you familiar with the guts of the (Accuvote) machine? Is the Diebold machine capable of launching a timed release using the clock chip at any time? Does the existing clock chip have the capability of being manipulated?" Dr. Appel stated he was not sure, but would assume that a computer chip that is operating in the machine and knows what time it is and has a real time clock chip that, among other things, can print the current time and date. The software program has access to the clock chip. The program needs to know the time and relies on the clock chip for this information.

In recognition of his time spent with us, Secretary Gardner presented Dr. Appel with a copy of the New Hampshire ratification document of the U.S. Constitution. He provided some history that reflects the state's past role in national elections and the way it perceives itself. He explained that New Hampshire was the ninth and deciding state in the ratification process; Virginia came a week later. After that, our national government was implemented in a matter of 6 months. During that period, the U.S. Senate was initially able to get a quorum, but the House was not. Senator John Langdon of New Hampshire was named the first President of the U.S. Senate. When the House organized, they had to count the votes for the electors in order to seat George Washington as the first president. New Hampshire was the first state to cast a vote for President Washington because they started the count from the north and finished it in the south. It was decided in joint convention that New Hampshire would be the first. Secretary Gardner presented the copy of the parchment to Dr. Appel and stated, "This document is what made us a nation."

Mr. Manning said it was a delight to have Dr. Appel here to help the Committee bring its thinking together for the final Committee report. Mr. Manning asked if there was any other business. Since there were no further questions, the meeting was adjourned.

The meeting was adjourned at 3:30 PM.

Minutes taken and typed by: Colleen McCormack-Lane

Received by: _____
Thomas Manning, Temporary Committee Chair