VoTeR Center

UConn Center for Voting Technology Research

PI : A. Russell, Ph.D.
Co-PIs : L. Michel, Ph.D., B. Fuller, Ph.D.
Research Associate: J. Wohl, G. Johnson

Technological Audit of Memory Cards for the November 2, 2021 Election

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The University of Connecticut Center for Voting Technology Research (VoTeR Center) performed an audit of the memory cards containing programming for the Accu-Vote Optical Scan (AVOS) tabulators used in the November 2, 2021 elections. The cards were programmed by LHS Associates of Salem, New Hampshire and shipped to the election officials of Connecticut's cities and towns.

The memory cards examined for this audit were submitted to the VoTeR Center by local election officials. The memory cards were either submitted voluntarily or because the precinct in which they were used was one of the 5% of precincts across the state selected to participate in a post-election manual-count audit.

The goal of the technological audit is to monitor the health of Connecticut's elections through examination of the memory cards used to program the AVOS tabulators that process cast ballots. The examination includes inspection of the binary contents of the memory cards as well as a higher-level analysis of the audit log contained on the memory card. Examining the binary contents of a memory card can reveal faults in the memory card or the systems that write to it. Analyzing the audit log can indicate the degree to which published election procedures have been followed.

1 Audit Procedure

The technological audit processing consists of two procedures: an automated integrity check that validates the contents of the memory card, and an automated audit log analysis that validates the sequence of events recorded in the memory card's audit log. The audit tools operate on an image of the contents of the memory card extracted using the AVOS tabulator.

The integrity check is carried out using a tool that performs a byte-level comparison between the image extracted from a memory card and a "baseline" image.[1] The integrity check focuses on regions in the image that contain sensitive data, including the election and candidate metadata, the addressing data of the candidate counter data, and the bytecode used to format the election results on the tabulator's result tape.

The log analysis tool examines the audit log entries in the memory card image to ascertain the presence or absence of events as well as verify the timing of events all of which may suggest problems with the memory card programming or tabulator hardware. Additionally, the analysis can validate the consistency of the audit log with the prescribed election processes. The log analysis tool either labels the sequence of audit log events as an expected sequence, or identifies instances where the event sequence contained unexpected events, out-of-sequence events, or events with an unexpected timestamp.

2 Audit Results

The VoTeR Center received 62 memory cards between October 29, 2021 and February 2, 2022. The memory cards were programmed for use in 48 precincts across 11 towns. Of the 62 cards analyzed, 27 appear to have been used in an election.

The audit log analysis tool identified some minor timing deviations from the recommended procedures.

Timing Issues Certain memory cards carried out ballot counting after the day of the election. Specifically, these cards completed the election-day procedure on 11/04, 11/05, and 11/08, when the election took place on 11/02. Details appear below.

1. The card showing activity on 11/08 was used during a re-canvass after the election day and the log entries are therefore normal.

2. The cards with activity on 11/04 and 11/05 all belonged to the same town, referred to here as Town A. A conversation with the registrars of voters revealed that there was a town-wide recount, explaining why there was activity after the election date. Town A explained that it is possible that equipment failure required them to use multiple cards. Specifically, the registrars stated:

   > We had a town wide recount. Had to run all ballots through fresh tabulators. We will check for paperwork for the cards you mentioned. It is possible equipment failure had us use multiple cards. Will need to review records.
   >
   > – The Registrars

The registrars from Town A have since sent us ticker tape from two of the three districts that had this issue.

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[1] An image that represents the state of a memory card that has been programmed but not used.

Process Issues   Two cards were found to be corrupted, one from Town B and one from Town C. However, this might have been due to errors when the card data was uploaded to our system. Town B sent us a pre-election card (that was not used in the election) and Town C sent us a post-election card (that was used in the election). The registrar from Town B explained that they had no issues with their card. Specifically, they stated:

> [...] we did not have any problems with any of the cards.
>
> – The Registrars

Town C also explained that they had no problems. They stated:

> We had no problems with our memory cards.
>
> – The Registrars

Corruption Issues   Three incidents are highlighted below

1. One card reported integrity errors. These errors could represent a number of different issues, several of which are benign. However, **we recommend this card be replaced and not used in further elections**. It should be noted that this card was not originally planned to be used during the election. Indeed, LHS gave the town this card as a substitute for a missing card.

2. In one case, a card was used on election day but appeared to have been abandoned before ballots were counted and a report was generated. The registrars explained to us that there was a power issue with the AVOS they were using, so they switched to a backup. However, the issue was actually due to a faulty power outlet. When they switched to a different outlet, they kept using the backup AVOS, resulting in logs for the original memory card to appear incomplete. Clearly, the issue was not related to the card or the AVOS, but to the power supply and the process handled the problem gracefully. **No actions required.**

3. One card failed pre-election testing. It reported incorrect vote totals after processing a test deck of ballots. There were three pre-election tests, with the first two failing and the last test succeeding. The registrars decided to not use the card and tabulator that failed these tests. The registrars also reported that the tabulator did not fail any tests when using other cards. **We recommend to service and test the AVOS tabulator and possibly remove the card that experienced the failures from circulation if the tabulator is exonerated.**

3   Conclusion

The Center for Voting Technology Research at the University of Connecticut has examined 62 memory cards from the November 2, 2021 Election to validate the programming of the cards and to determine the degree to which local election officials have adhered to the election process.

All of the audited cards contained the appropriate programming for the precincts on their label. One of the cards contained an error that may indicate a possible corruption. We recommend replacing this card. Another card showed inconsistent counter values during pre-election testing that may indicate a problem with the AVOS machine. This AVOS machine should undergo testing and diagnostics. If no problems are found with the machine, we recommend replacing the card.

In all but a small number of cases, the audit logs on the audited cards describe an expected event sequence. For the small number of unexpected sequences that could not be readily identified, election officials were contacted. The explanation provided by election officials made clear that the situation had been handled appropriately.