VoTeR Center

UConn Center for Voting Technology Research

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Technological Audit of Memory Cards for the November 3, 2020 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 that were used in the November 3, 2020 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 that are 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 give insight into 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 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 detect the presence and timing of events that indicate a problem with the memory card programming or tabulator hardware, and also to validate the the election process described by the audit log event sequence. The result of the log analysis is either that the log analysis tool labels the sequence of audit log events as an expected sequence, or the tool records instances where the event sequence contained unexpected events, out-of-sequence events, or events with an expected timestamp.

2 Audit Results

The VoTeR Center received 57 memory cards between November 9, 2020 and February 23, 2021. The memory cards were programmed for use in 55 precincts across 10 towns. Of the 57 cards analyzed, 22 appear to have been used in an election.

The result of the integrity checks of the 57 cards was that there were no unexpected differences in sensitive areas of the memory card images. There was one difference identified far outside the address range of structured data. These appear on rare occasions and are believed to be the result of a transient read/write error.

The audit log analysis tool identified some minor timing deviations from the recommended procedures. In some cases, the tool identified initialization events (performed at LHS) and ballot testing events (performed by town election officials) that occurred outside of the expected window of time. In

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

one case, initialization outside of the approved window of time may have resulted in delayed ballot testing, but even the delayed ballot testing occurred sufficiently far in advance of election day to allow the election to be carried out as normal.

There was one case in which the events that should have occurred on election day were recorded with timestamps on the following day. While this is often a sign that the system date on the tabulator is set incorrectly, in this case the original tabulator's ballot rollers had failed and prevented the tabulator from accepting ballots. The tally was completed the next day with a different tabulator and memory card. This card is the one submitted to the audit.

There was one case in which the audit log indicates that the card was tested as normal and that there were ballots recorded as cast on the tabulator, but the result printing event was never recorded. The last entry in the log indicates that the tabulator lost power before the results could be printed. In most cases, this indicates that the tabulator was powered down after the user printed the full totals report but before they confirmed that they were done printing results. The VoTeR center contacted town election officials to inquire about the details. An election official familiar with the matter verified that the totals were printed.

In one memory card, there were signs that the memory card had been programmed using the card duplication feature offered by the AVOS. This is a low-risk event. The AVOS offers a memory card duplication feature, but memory cards should be programmed exclusively by LHS and so the use of the duplication feature is discouraged.

3 Conclusion

The Center for Voting Technology Research at the University of Connecticut has examined 57 memory cards from the November 3, 2020 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 memory cards contained a stray non-zero value in an address space that is unused and usually contains only zeros. Such stray values are uncommon but have been seen before. The VoTeR center believes such errors result from isolated read or write faults, and so have no effect on the vote tallies.

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 relevant election officials made clear that the situation had been handled appropriately.