Evidence-Based Elections

NH Election Integrity Project

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Trustworthiness before trust

– Onora O'Neill

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- **Every** computerized system can have software bugs and be hacked.
- **Any** process that involves people eventually will make mistakes.
- To provide evidence that reported winners really won, must be able to check whether reported winners really won *without trusting software/computers*, *despite any human error*.

Security properties of paper

- tangible/accountable
- tamper-evident
- to change many votes requires physical access & accomplices

How paper is marked, curated, & audited are crucial

- A paper trail created using untrustworthy technology is (almost) worthless
  - Hand-marked paper ballots are a record of what the *voter* did
  - Machine-marked paper ballots are a record of what the *machine* did
- A paper trail that is not kept (demonstrably) secure is worthless
- A paper trail that is never examined might as well not exist

Did the reported winner really win?

- Procedure-based vs. evidence-based elections
  - sterile scalpel v. patient's condition

Evidence = auditability + auditing

Evidence-Based Elections

P.B. Stark and D.A. Wagner

***Abstract*—We propose an alternative to current requirements for certifying voting equipment and conducting elections. We argue that elections should be structured to provide convincing affirmative evidence that the reported outcomes actually reflect how people voted. This can be accomplished with a combination of software-independent voting systems, compliance audits, and risk-limiting audits. Together, these yield a resilient canvass framework: a fault-tolerant approach to conducting elections that gives strong evidence that the reported outcome is correct or reports that the evidence is not convincing. We argue that, if evidence-based elections are adopted, certification and testing of voting equipment can be relaxed, saving money and time and reducing barriers to innovation in voting systems—and election integrity will benefit. We conclude that there should be more regulation of the evidence trail and less regulation of equipment, and that compliance audits and risk-limiting audits should be required.**

***Keywords*-elections, software-independent voting system, risk-limiting audit, resilient canvass framework EDICS SEC-INTE, APP-CRIM, APP-INTE, APP-OTHE.**

I. Introduction

IDEALLY, what should an election do? Certainly, an election should find out who won, but we believe it also should produce convincing evidence that it found the real winners—or report that it cannot. This is not automatic; it requires thoughtful design of voting equipment, carefully planned and implemented voting and vote counting processes, and rigorous post-election auditing.

While approximately 75% of US voters currently vote on equipment that produces a voter-verifiable paper record of the vote, about 25% vote on paperless electronic voting machines that do not produce such a record [1].

Because paperless electronic voting machines rely upon complex software and hardware, and because there is no feasible way to ensure that the voting software is free of bugs or that the hardware is executing the proper software, there is no guarantee that electronic voting machines record the voter's votes accurately. And, because paperless voting machines preserve only an electronic record of the vote that cannot be directly observed by voters, there is no way to produce convincing evidence that the electronic record accurately reflects the voters' intent. Internet voting shares the shortcomings of paperless electronic voting machines, and has additional vulnerabilities.

Numerous failures of electronic voting equipment have been documented. Paperless voting machines in Carteret County, North Carolina irretrievably lost 4,400 votes; other machines in Mecklenburg, North Carolina recorded 3,955 more votes than the number of people who voted; in Bernalillo County, New Mexico, machines recorded 2,700 more votes than voters; in Mahoning County, Ohio, some machines reported a negative total vote count; and in Fairfax, Virginia, county officials found that for every hundred or so votes cast for one candidate, the electronic voting machines subtracted one vote for her [2]. In short, when elections are conducted on paperless voting

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Any procedure with known maximum chance of not correcting the reported outcome if the reported outcome is wrong (& never alters correct outcomes).

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Establishing whether paper trail is trustworthy involves other processes, generically, *compliance audits*, solid canvass procedures

Risk-Limiting Audits

- Endorsed by NASEM, PCEA, ASA, LWV, CC, VV, ...
- ~60 pilot audits in AK, CA, CO, GA, IN, KS, MI, MT, NJ, OH, OR, PA, RI, WA, WY, VA, DK.
- Routine in CO since 2017. Statewide audits in AK, KS, WY in 2020; "almost" statewide in PA in 2021.
- Laws in CA, CO, RI, VA, WA
- Methods for all social choice functions used in US elections

Core idea:

Seek *affirmative* evidence that the reported winner(s) really won.

Keep examining more ballots until there is strong evidence that a full hand count would find the same winners–or until there has been a full hand count.

- If the paper trail is not trustworthy, no procedure can guarantee any chance of catching and correcting wrong results.
- Many ways to implement RLAs. All require human eyes on (trustworthy) physical paper.
- Flexibility: accommodate different equipment, canvass procedures, paper organization, social choice functions

Main strategies

- ballot polling
- batch-level comparison
- ballot-level comparison
- hyb

Tools for Ballot-Polling Risk-Limiting Election Audits

To hide or show everything but the tools, click this link.

Initial sample size

Initial sample size

Contest information

Ballots cast in all contests: 805058 Smallest margin (votes): 59,267. Diluted margin: 7.36%.

Contest 1. Contest name: President

Winners: 1

Reported votes:

Candidate 1 Name:	Biden	Votes:	424921
Candidate 2 Name:	Trump	Votes:	365654
Candidate 3 Name:	Jorgensen	Votes:	13235
Candidate 4 Name:	Hawkins	Votes:	217
Candidate 5 Name:	Sanders	Votes:	192
Candidate 6 Name:	Romney	Votes:	170
Candidate 7 Name:	Gabbard	Votes:	142
Candidate 8 Name:	West	Votes:	82

Add candidate to contest 1 | Remove last candidate from contest 1

Add contest | Remove last contest

Audit parameters

Risk limit: 5% Expected sample size: 1,098.

Tools for Comparison Risk-Limiting Election Audits

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Contest type: (•) plurality ( ) super-majority

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[Add candidate to contest 1] [Remove last candidate from contest 1]

[Add contest] [Remove last contest]

Audit parameters

Risk limit: 5%

Expected rates of differences (as decimal numbers):

Overstatements. 1-vote: 0.001 2-vote: 0.0001

Understatements. 1-vote: 0.001 2-vote: 0.0001

Starting size

[x] Round up 1-vote differences. [ ] Round up 2-vote differences. [Calculate size] 92.

Principles for legislation

- require *compliance audits*, ballot accounting, pollbook reconciliation, custody & eligibility checks
- require *ballot manifests* constructed w/o reliance on the voting system
- audit before certification; audit must be able to correct the results (by full count)
- if not every contest is subject to RLA, specify how to choose contests to audit
- specify risk limits
- collect audit data on all contests; report "measured risk"
- legislate principles, not methods
- public participation in generating randomness (e.g., die rolling)
- public gets enough info to verify audit didn't stop before it should

Evidence-Based Elections: 4 C's

- Voters *CREATE* complete, durable, verified audit trail.
- LEO *CARES FOR* the audit trail adequately to ensure it remains complete and accurate.
- Compliance audits *CHECK* that paper trail is trustworthy
- Risk-limiting audits *CHECK* or *CORRECT* reported results