Evidence-Based Elections

Philip B. Stark[*]

Department of Statistics
University of California, Berkeley

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[*]Joint with many, incl. J. Benaloh, J. Bretschneider, J. Hall, D. Jones, E. Lazarus, M. Lindeman, D. Wagner, V. Yates

What do we want Elections to do?

Evidence-Based Elections

An election should produce convincing qualitative and quantitative evidence that it found the right winners—or report that it cannot.

How can we do it?

Evidence = Auditability + Auditing

Combination:

Voting system that produces durable, voter-verifiable records (VVPR).

Compliance audit to ensure the integrity of those records.

Risk-limiting audit of the records to verify that the apparent winners really won.

Resilient Canvass Framework
Large chance of correcting its own errors.
If it can't, it says so.

Generating and Assessing Evidence

Audit trail

Typically, VVPR.

Compliance Audit

Is the system, as maintained & used, strongly software independent?
Was audit trail complete and accurate when generated, and curated
adequately since?

Risk-limiting Audit

To pass, need convincing evidence that full hand count would find the
same outcome—or a full hand count.

Large, known chance of requiring a full hand count if the outcome is
wrong, no matter why.

Risk is biggest chance of not correcting a wrong outcome.

Evidence-Based Elections:
Compliance Audits + Materiality Audits

Effective compliance audit

Determine whether the audit trail is trustworthy enough to determine who won.

Was the system, as deployed—including curation of the audit trail—strongly software independent?

If not, do not declare an outcome.

Effective materiality audit

If the outcome is wrong, correct it (with high probability).

Requires intact audit trail–need to pass compliance audit first.
Might require counting the entire audit trail by hand.

VTS Certification vs Risk-Limiting Audits

Question 1

In the lab, can the vote-tabulation system—as delivered from the manufacturer—count votes with a specified level of accuracy?

Question 2

As maintained, deployed, and used in the current election, did the vote-tabulation system find the true winners?

Only care about Q1 insofar as it matters for Q2.

Certification addresses Q1. Risk-limiting audits address Q2.

Risk-Limiting Audits

Required by Colorado Revised Statutes 1-7-515
Pilot mandated by California AB 2023.

- Guarantees a large chance of correcting the outcome if it is wrong (if audit trail is sufficiently intact).

- "Intelligent" incremental recount: stops only when there is convincing evidence that a full hand count won't change the outcome.

- Until the evidence is strong, counting continues, possibly to a full hand count.

- Absent a full hand count, will not alter election outcomes: Can correct wrong outcomes, but can't harm correct outcomes.

Risk-Limiting Audits

- 16 pilot audits in CA, CO, and OH; another 14 planned
- EAC funding for pilots in CA and CO and Cuyahoga County, OH
- CO has law; CA has pilot law
- simple measures
- measures requiring super-majority
- multi-candidate contests
- vote-for-n contests,
- multiple contests audited simultaneously with one sample
- contest sizes: 200 ballots to 121,000 ballots
- counting burden: 16 ballots to 7,000 ballots
- cost per audited ballot: nil to about $0.55.

Ballot-polling audit: representative (statewide) sample sizes

margin	median ballots		90th percentile	
	10% risk	1% risk	10% risk	1% risk
5%	1,200	2,900	3,800	6,700
3%	3,700	8,400	11,000	19,000
2%	8,200	19,400	24,000	42,000
1%	33,000	77,000	97,000	167,000

Does not require special technology, only a paper trail.
Feasible **today** in all states that have a paper audit trail, e.g., Ohio.

Let's Get Out the Audit!