

Evidence-Based Elections

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Verifiable is not enough: need **verified**

Evidence-based Elections

LEOs should give convincing evidence that outcomes are right (or say they can't)

- “Trust me” is not convincing.
 - “I used certified equipment” is not convincing
 - “No evidence of hacking” is not convincing (esp. if nobody looked)
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Evidence-Based Elections

- Voters *CREATE* complete, durable, verified audit trail.
- LEO *CARES FOR* the audit trail adequately to ensure it remains complete and accurate.
 - Conduct *compliance audit* to check whether the audit trail is trustworthy enough to determine who won.
- Auditors *CHECK* reported results against the paper
 - Full hand (re-)count fine, but unnecessarily expensive
 - Appropriately designed audit can detect and correct wrong outcomes
 - Risk-limiting audit currently the gold standard

Evidence = Auditability + Auditing

What do we want audits to do?

Correct the results before they are final, if they are wrong.

RLA WTF?

- Simple idea: audit has a large chance of requiring a full hand count, if that would show the reported outcome is wrong.
 - RLA is not a method. It's a property that some methods have.
 - Can't have RLA without voter-verifiable, durable, tamper-evident record: paper
 - A full hand count is a RLA
 - Some methods are much more efficient than full hand counts
 - Efficiency depends on voting equipment, local jurisdiction's logistics, etc.
 - Ballot-polling RLA
 - Comparison RLA
 - * batch-level
 - * ballot-level
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Digital images

- Why not just publish images?
 - How do you know they are complete and accurate?
 - More work to audit accuracy of the images than to do a RLA against the paper!
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What's missing?

BOTH for audits and for manual counts, need

- voter-verifiable paper
 - provable chain of custody
 - evidence that the paper trail is reliable
 - organization of the ballots
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Ballot-polling Audits are often Cheap for Big Contests

255 state-level presidential contests, 1992–2012, 10% risk limit

BPA expected to examine fewer than 308 ballots for half the contests.

Work expands as margins shrink, but we could get a lot of election integrity at low cost—with any paper-based system.

Ballot-Polling Audit, 2 Candidates, 10% Risk Limit

Winner's share	median	90th percentile	Mean
70%	22	60	30
65%	38	108	53
60%	84	244	119
58%	131	381	184
55%	332	974	469
54%	518	1,520	730
53%	914	2,700	1,294
52%	2,051	6,053	2,900
51%	8,157	24,149	11,556
50.5%	32,547	96,411	46,126

Risk-Limiting Audits

- ~25 pilot audits in CA, CO, and OH; AZ

- simple measures, super-majority, multi-candidate, vote-for-n
 - 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
 - CO law goes into effect this year; RI law just passed; CA has pilot laws
 - Conference of California Bar Associations is proposing CA legislation
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Other auditable aspects of elections

- registration
- signature verification for VBM
- provisional ballot adjudication
- ballot usability