

# Presentation at National Election Integrity Conference Berkeley, CA



2019-10-06 Ray Lutz  
Citizens' Oversight Projects  
[CitizensOversight.org](https://CitizensOversight.org)

# Ray Lutz

- Master's degree in electronic and computer engineering
- Significant industry and standards experience in document processing equipment, including printer, scanners, facsimile, imaging, etc.
  - Involved in national and international standards development
  - Experience with test-strategy development for VLSI (very large scale integrated) circuits
  - Managed a quality assurance department in a manufacturing setting
- Involved in providing oversight to audits throughout CA, FL, MI, and other states.
- **Recently investigated RLAs incl. Monte Carlo simulations**
- Founder and Executive Director of **Citizens' Oversight**, a 501(c)3 nonpartisan nonprofit charity organization.

# Topics of this Presentation

- Brief update of oversight activities
- Explain the limitations of statistically sampled paper audits ("RLAs")
- Provide the best vision for the future:
  - Ballot Image Audits as the primary tool
  - Sampled paper ballots to validate images
- Announcement of AuditEngine.org
  - cloud-based ballot image audit tool that can be used by election officials and oversight groups.

# Common Ground

Robust audits are essential in  
protecting our elections

But audits done improperly are just  
theater and can cover up election  
manipulation

# Update of Recent Activities

- Organized audit oversight teams in CA and other areas that have audits such as FL (you can help!)
- Discovered that San Diego was leaving out about 37% of the ballots from the audit.
  - Asked them to include them.
  - They decided they would rather fight it in court.
  - We won the lawsuit, but on appeal, CACEO pushed through AB-840 to allow omission of later VBM ballots.
- Also attempted to access 2016 ballots using a contest and Public-records request approach.
  - Both failed (ballots are sealed) but we learned a lot.

# What is RISK?

- “Probability Risk Assessment” (PRA) is the primary statistical methodology used by scientists and engineers
  - PRA has been used in nuclear reactors and NASA spacecraft designs esp. since the 1980s
  - Predates elections RLAs in terms of defining “Risk”
- **Risk = (Probability of Adverse Event) x (Consequence)**
- RLA advocates provide an incomplete analysis of the risk and **ignore numerous hazards added by the RLA process itself.**
- In RLA publications (Stark, Lindemann, Rivest, etc), “risk” is **only the sampling error and not the comprehensive risk.**

# The Key Election Audit Hazard

- Election officials are auditing themselves!
- Election workers tend to seek a “clean audit”
  - Workers correct problems throughout the election process every hour of every day.
  - During the audit, they may innocently correct problems in the sampled cases rather than reporting them. We call this “**innocent fix-up.**”
  - But such corrections during the audit are not allowed and defeat the audit.
- Audits should be simple or mistakes and innocent fix-up can defeat them.

# ELECTION HAZARDS

There are many hazards in processing an election

Some mistakes and errors are EXPECTED in canvass process

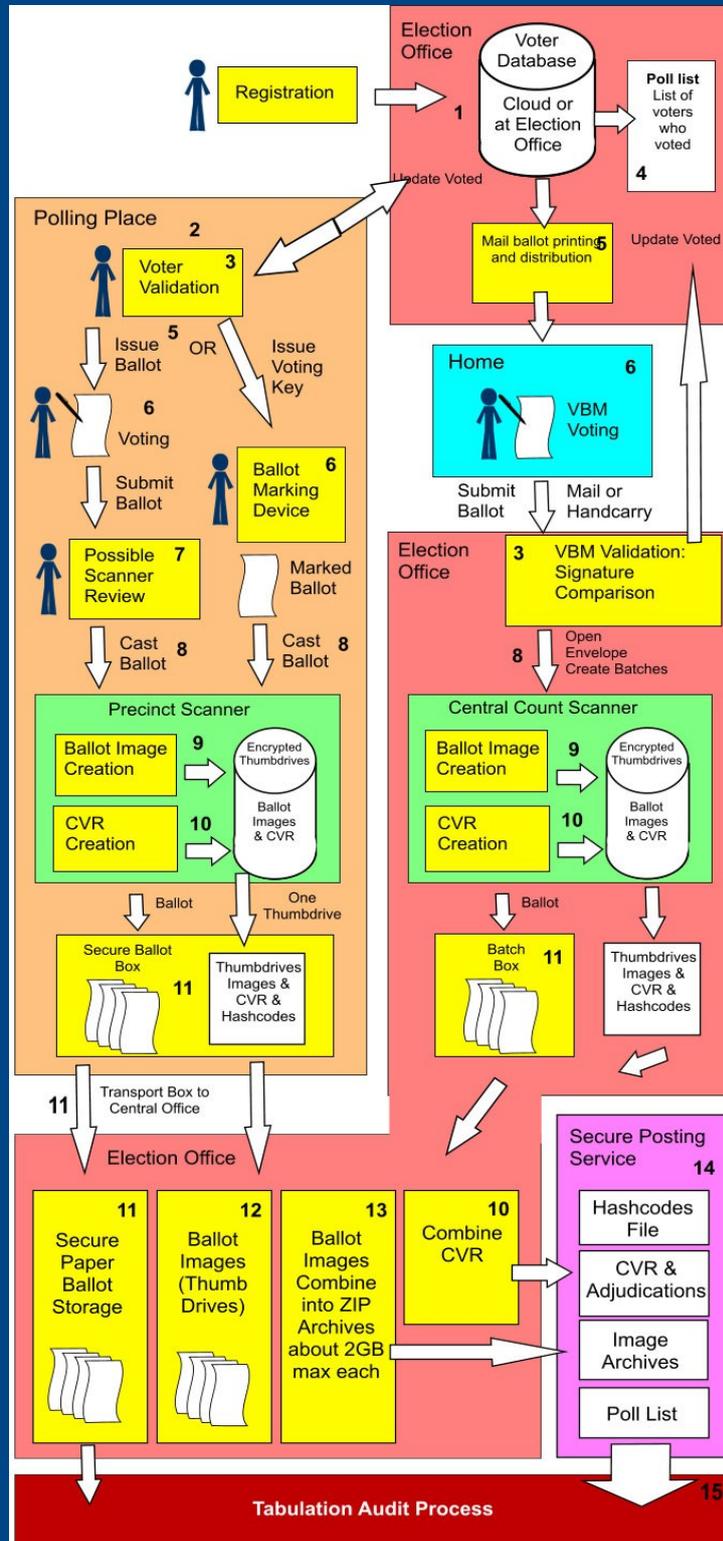
- Voter Intent Interpretation
- Processing mistakes (missing batches or batches scanned twice)

Some hazards are due to malicious attack

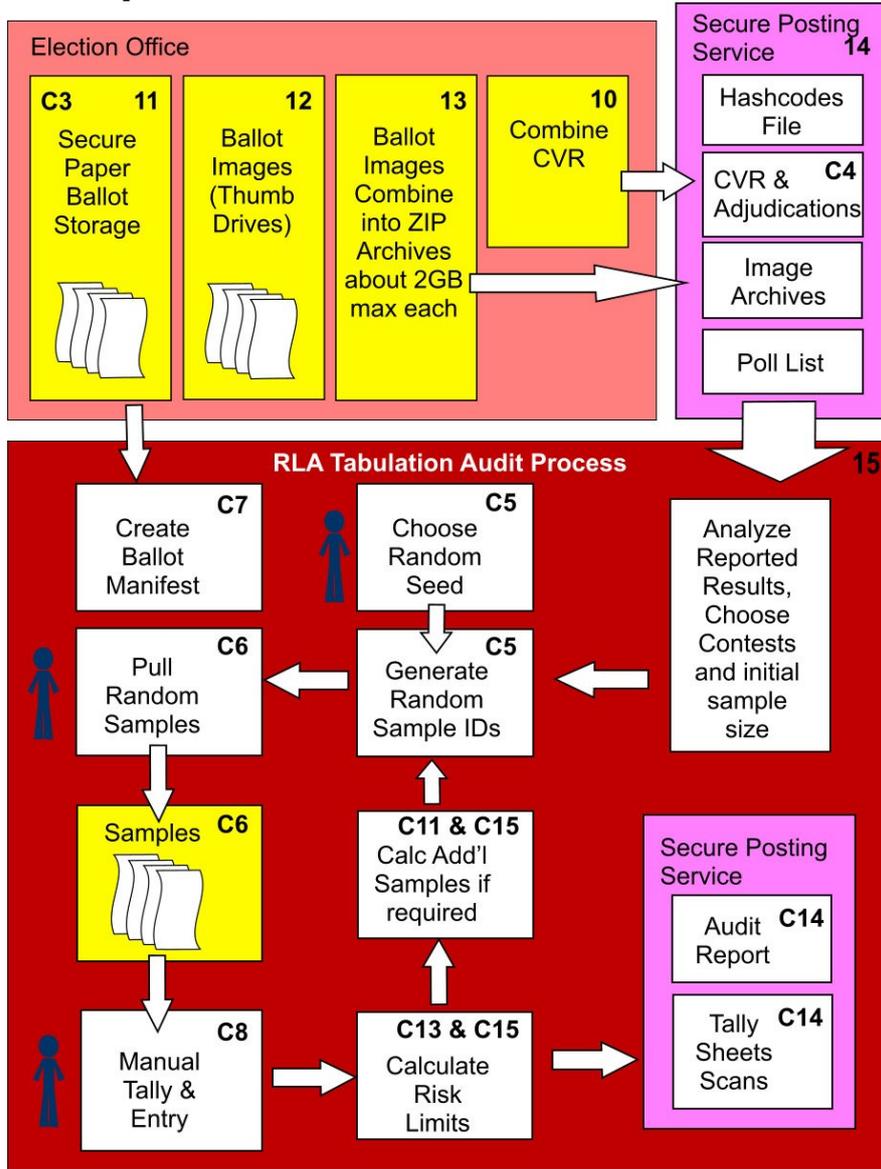
- Such attacks would likely only be launched against CONSEQUENTIAL contests.
- Auditing can catch many but never all hazards.

## Election Hazards

1. Registration:
  - > Malicious purges/ changes
  - > Early deadlines
  - Mitigation: same day reg./ERIC
2. Polling Location Access
  - > Last minute changes
  - > too many voters, long lines
3. Voter Validation including Signature Comparison
  - > Difficult to obtain ID req.
  - > Signature comparison faults
4. Poll list errors
5. Issuing ballot errors
  - > Req. to request correct ballot
  - > Correct ballot availability
6. Marking errors (voter Intent) & Submission problems
  - > Use of unreadable bar codes
  - > Confusing ballot design
7. Scanner Review Misdirection
8. Security of Cast Ballot prior to scanning.
  - > Higher risk in central count
9. Ballot Image Manipulation prior to creating the CVR
  - > Higher risk in COTS scanner
  - > Limit risk by sampling paper
10. CVR Modification / Mismatch
  - > Voter Intent Misinterpretation
  - > Malicious CVR changes
11. Paper Ballot Security After scanning
12. Ballot Image on thumb drives Modification.
  - > Would require matching changes to CVR
13. Ballot Image Archive Creation and posting
  - > Would require matching changes to CVR
14. Posting Service Security
  - > Posting service security is key to their business model.
15. Hazards within the audit process that can defeat the audit, including reporting.
  - > Statistical audits that sample individual ballots have many hazards that may defeat the results.
  - > Ballot Image Audits can be redundantly checked to reduce hazard of compromised auditor.



## Paper-ballot review audit hazards



### Paper-ballot review audit hazards -- Can defeat the audit if:

- C1. Ballots are modified, added, or deleted prior to scanning.
- C3. Ballots are modified, added, or deleted after scanning but prior to sampling.
- C4. Cast-vote-records modified.
- C5. Random sample generated to avoid hacked samples
- C6. Drawing samples with to avoid hacked samples or in favor of desired option.
- C7. Ballot manifest manipulation to avoid hacked samples or in favor of desired option.
- C8. Manual Tally and data entry, "innocent fix-up", or DRE-like data entry w/o paper trail.
- C11. May result in a full manual count if margins are close.
- C12. May confirm a hacked election due to sampling error allowances.
- C13. May not include all contests, esp. small contests.
- C14. Incomplete or inaccurate reporting.
- C15. Calculation mistakes or hacks.

More Information: [CitizensOversight.org](http://CitizensOversight.org)

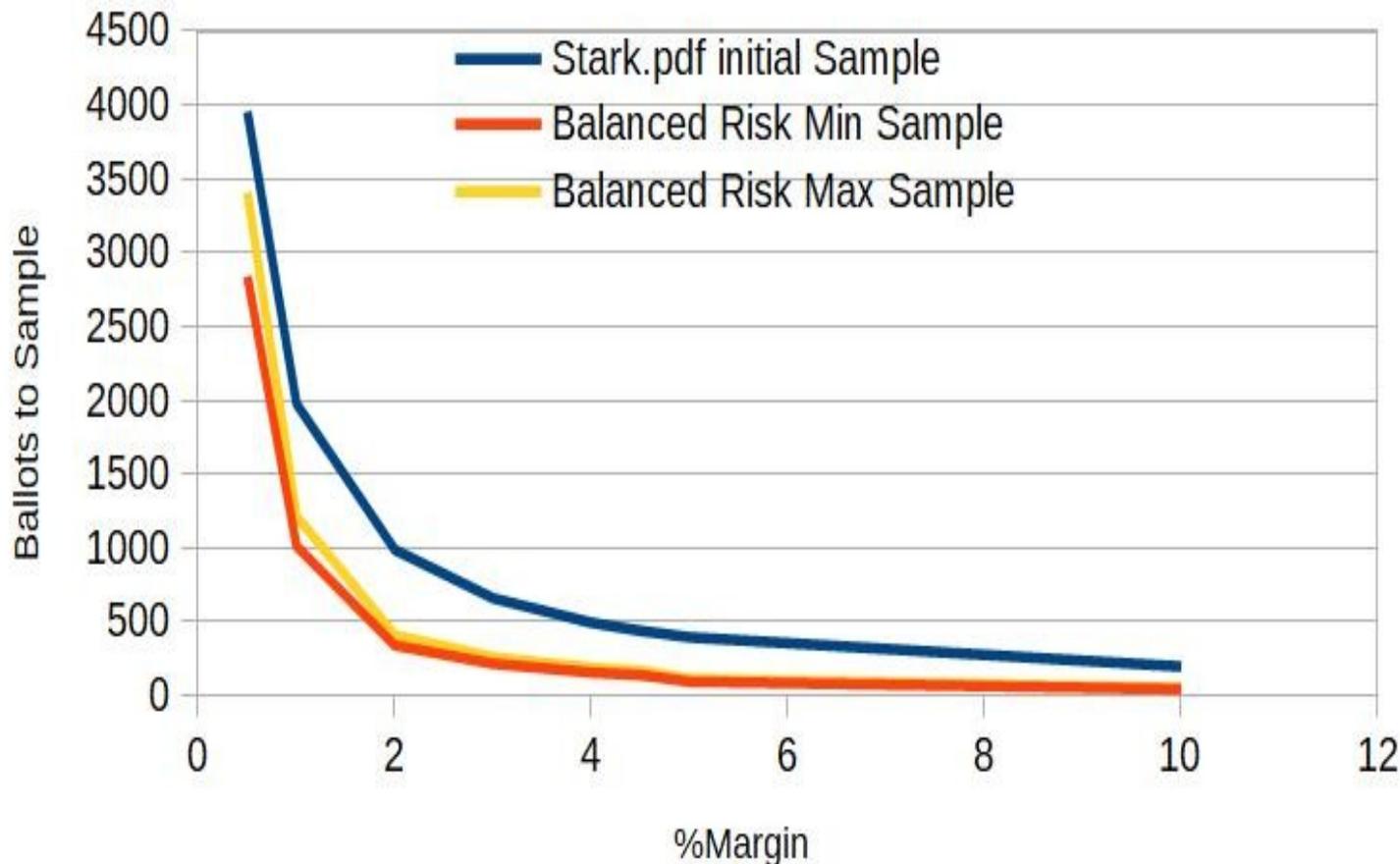
# Statistical RLA Weaknesses (1)

- The process of doing the audit is complex, difficult to perform, observe, and understand.
- Stirring soup analogy does not embrace the stark realities of drawing and organizing paper.
- Pushes humans to the limit of their ability to organize paper.
- Many manual steps introduces "innocent fix-up hazard" at every turn as audits are typically SELF AUDITS.
- RLA "Risk" is actually only the error rate of sampling, and not the comprehensive risk
- Close contests quickly expand to a "full hand count" with no other option proposed.

# RLA Sample sizes explode at close margins

Samples Required for Ballot Comparison RLA at 5% Risk Limit

Method starts to become infeasible at <2% margin



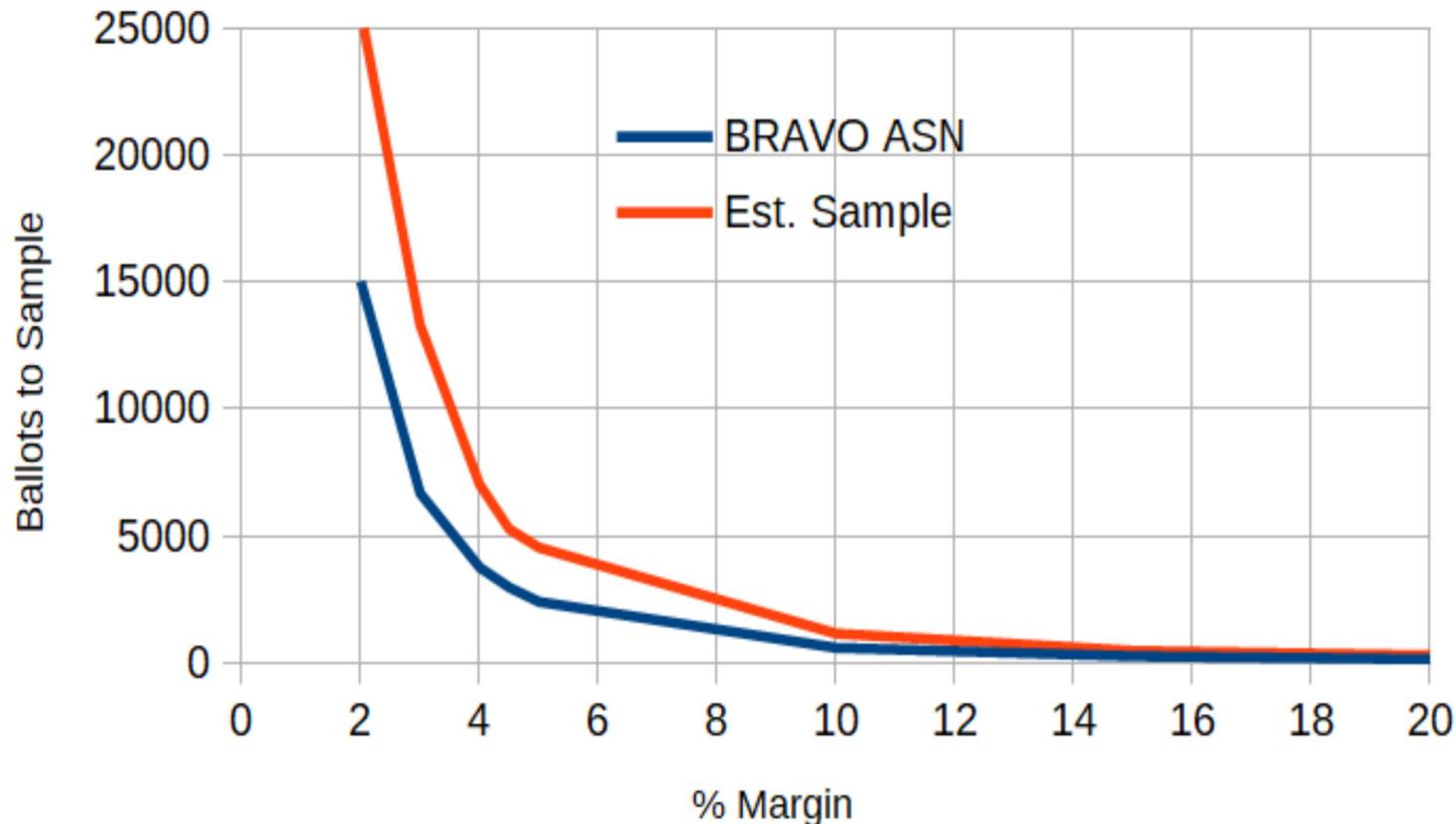
This is the most efficient of the RLA approaches but it typically **CANNOT BE USED** unless the state is an all VBM state that uses central-count scanners exclusively.

Precinct scanners do not maintain the link between paper and cast vote record and must be rescanned and numbered.

# Explosion even worse for Ballot Polling method

## Samples Required for Ballot Polling RLA at 5% Risk Limit

Method starts to become infeasible at <10% margin



This auditing method can be used with any equipment and does not require a CVR broken down by ballot. But the number of ballots sampled increases quickly at margins less than about 10%

Batch Comparison audit will require almost as many ballots but they are handled by batch, and are easier to implement.

# Statistical RLA Weaknesses (2)

- Typical implementation does not cover all contests of consequence.
  - But contests not explicitly audited are not “magically” audited
  - Adding coverage of local contests quickly becomes unwieldy.
    - The sample size is related to the MARGIN not the contest size.
    - Small contests require the same number of ballot samples as large contests, if a risk limit is to be respected.
    - Each contest in a set of non-overlapping districts must be adequately sampled.
- RLA procedures & publications do not help election officials choose contests to be audited.
  - If any set of contests are not all audited, then they should be randomly chosen weighted by consequence:
    - Close contests
    - Seats with highest power (President ~2000x consequence of house seat)
    - **Don't waste time on advisory or unopposed contests.**

# Ballot Image Audits (1)

- A ballot image is a high-resolution image of a hand-marked paper ballot.
  - “Ballot image” is no longer used to refer to the memory image of a DRE machine.
  - Most modern equipment produces these images and they should be preserved.
- A Ballot Image Audit (BIA) exhaustively recomputes the result of the election by retabulating *all* ballot images usually by third party services.
- Compatible with crowd-sourced audits.
- If ballot images are validated (compared with paper ballots), a BIA is a risk limiting audit, with lower overall risk than any other method.

# Ballot Image Audits (2)

- With validation, BIAs will reduce the overall risk to a lower level than RLAs (I disagree with Dr. Stark that image validation is harder)
- Can cover all contests, even small ones, down to the ballot for most hazards.
- Does not explode into costly hand counts.
- Can detect, even without ballot image validation:
  - All voter intent issues
  - Nearly all election processing errors
  - Nearly all malicious attacks – like "Fraction Magic"
- Provides higher confidence to election officials
- Minimizes “innocent fix-up” errors.
- Compatible with third-party audit services
- Compatible with all precinct scanners which do not keep ballots in order (and some actively scramble the images and CVR).

# Ballot Image Validation

- Ballot image Validation is a review of paper ballots to validate that the images are a faithful representation of the paper.
- A limited statistical RLA is sufficient.
  - A limited traditional RLA of consequential contests will also validate ballot images for those contests.
  - Ballot images need not be explicitly inspected.
  - Guards against malicious modification of ballot images prior to being secured.
  - Small local contests are not consequential enough for hackers to manipulate the images, which is computationally difficult.
  - Image validation as easy or easier than full RLA.

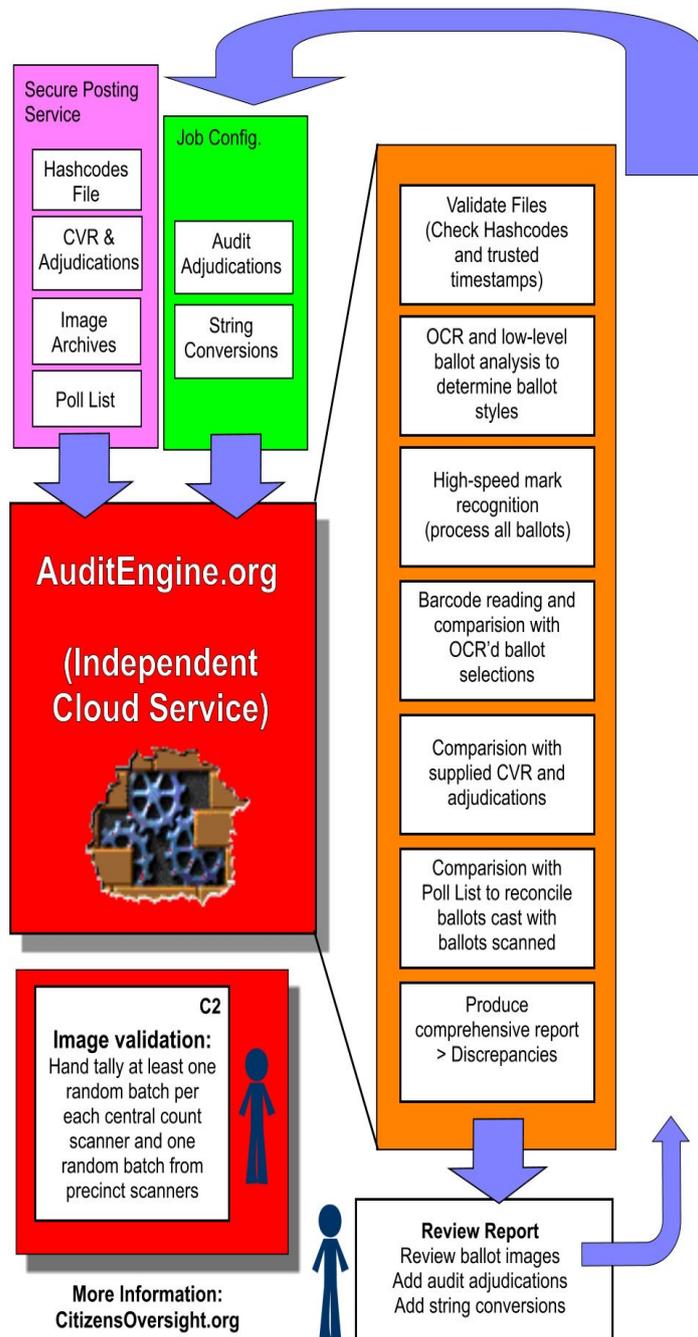
# The Only Malicious BIA Attack (During the tabulation phase)

- Malicious attack of BIA secured election would require modifying ballot images prior to being secured and before the Cast Vote Record (CVR) is created.
- Ballot images are used to generate the Cast Vote Record.
- Thus, the CVR is also modified and will not match the paper ballots.
- Such an attack would likely be for consequential races
- An RLA of consequential races therefore also validates ballot images against such a malicious attack.
  - All other contests can be included in the BIA with confidence down to the ballot.
  - The sampling RLAs were not including these contests to any viable level of confidence anyway.

# Recommendation for Future

- Use ballot image audits for local races.
  - Ballot image audits will resolve voter intent and processing errors of small local races.
  - Ballot images must be secured and (at least) hash codes posted on a secure server with trusted timestamps (Like Sharefile.com and other services).
  - Independent BIA services can be used for this process.
- Batch Comparison Audit of the most consequential contests
  - Cover any contest with spending over \$1 million per candidate.
  - No need to re-scan ballots
  - Logistics to pull samples simpler, easier to oversee
  - Traditional canvass report will suffice, but must be broken down by precinct.
  - This process also validates the ballot images.

# Ballot Image Audit: AuditEngine



# AuditEngine.org

Upload files to the website

- Image archives
- Cast vote record (optional)
- Poll List (Total Voters who signed in at polls, and returned VBM ballot)
- Hashcodes file
- Adjudications (manual interpretations of ballots)

Launch audit and Review the report

Review individual ballots and add adjudications

Perform Image Validation of consequential contests

# Audit oversight is important

- We need people in every county that performs audits
- Insure the computer report (CVR) is frozen prior to random draw
- Watch and record the random draw
  - Do they include all the ballots in the draw
- Watch what they do **AFTER** the batches are tallied.
  - Do they rescan the ballots (Innocent fix-up).
- Review the reports

# Moving Forward

- Volunteer to provide audit oversight in your region.
- We want as many ballot image sets and CVRs as possible, from every vendor for testing.
- Spend more time to understand the trade-offs between different auditing strategies.
- Contact:
  - Ray Lutz – [CitizensOversight.org](https://CitizensOversight.org)
  - Facebook: Election Scam Clearinghouse (open group)
  - [raylutz@citizenoversight.org](mailto:raylutz@citizenoversight.org)
  - 619-820-5321
  - Get on our email alert list