Election Technology

Achieving Security and Trust

Louisiana Voting System Commission
December 14, 2021

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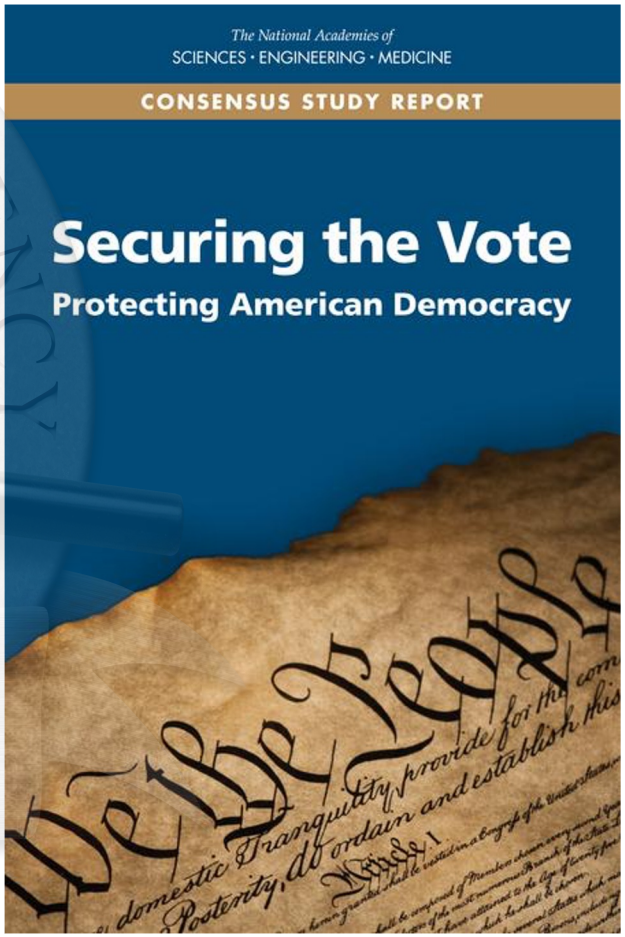
The Challenge of Election Security

Consensus of the National Academies:

> "There is no realistic mechanism to *fully secure* vote casting and tabulation computer systems from cyber threats."

Challenge for election systems:

How to achieve security and public trust with imperfect technology?



My Background

Cybersecurity research
Work to apply science and technology to make elections more secure and trustworthy

Election security analysis
Conducted security reviews and discovered vulnerabilities in both models of paperless machines currently used in Louisiana

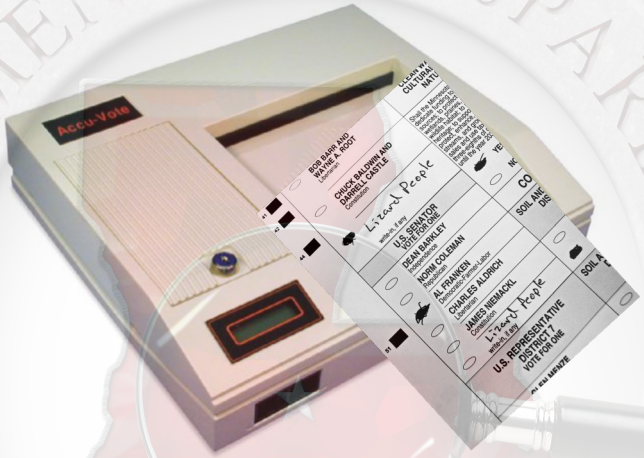
Collaboration with election officials
Lead Michigan's Secretary of State's election security advisory commission

My testimony today addresses threats faced by different styles of voting systems. Not offering opinions on specific vendors or products

U.S. Voting Machines

DRE (Direct-Recording Electronic)

Votes cast on screen, recorded in memory. Some models also print a paper audit trail (VVPAT)



Hand-Marked Optical Scan

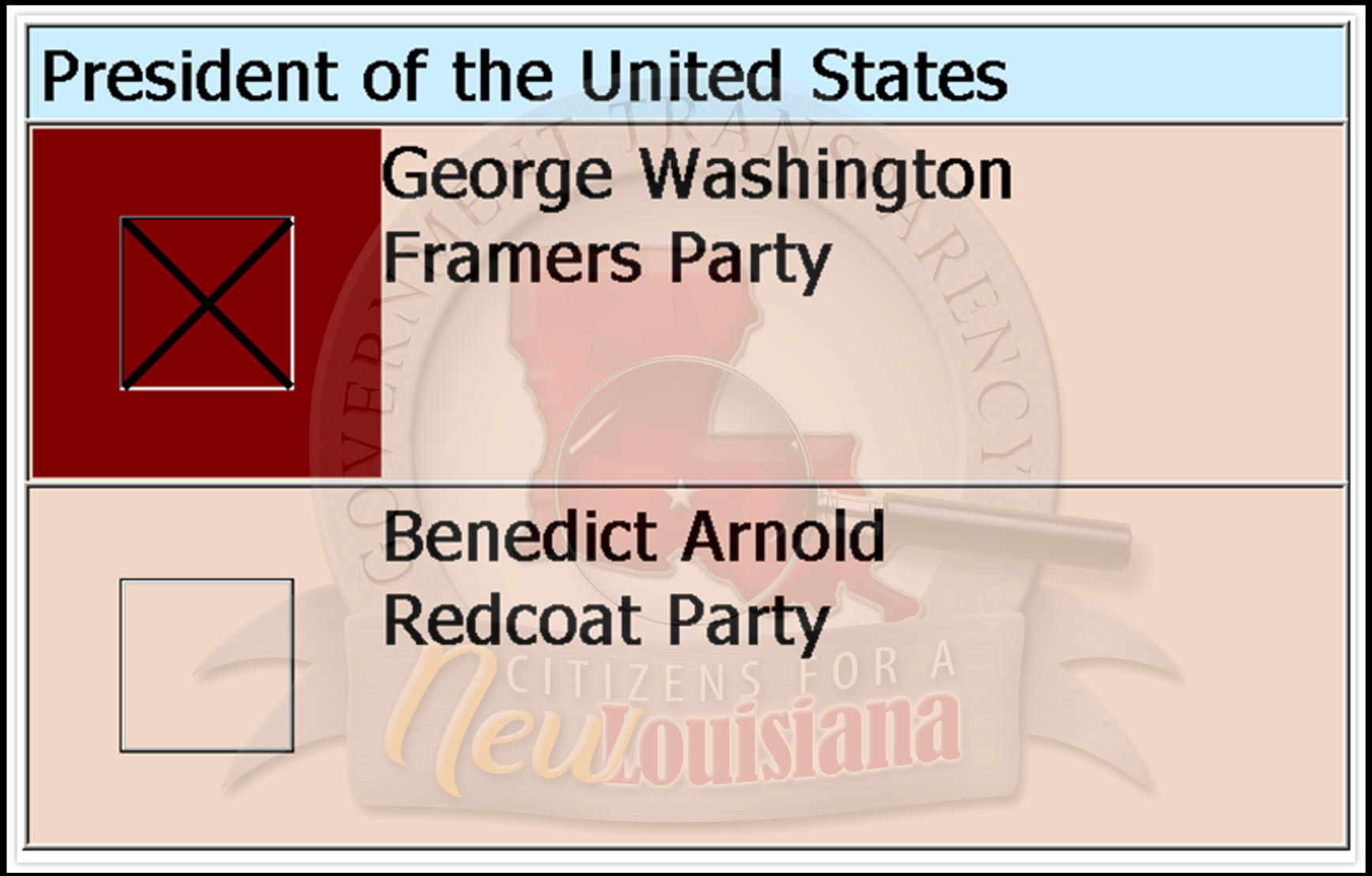
Computers count hand-marked ballots received by mail or as they're deposited in a ballot box

BMD (Ballot Marking Device)

Votes cast on screen, printed on paper, then counted by scanners. Used for accessibility or by all

Non–paper-ballot systems: Mostly phased out as of 2020

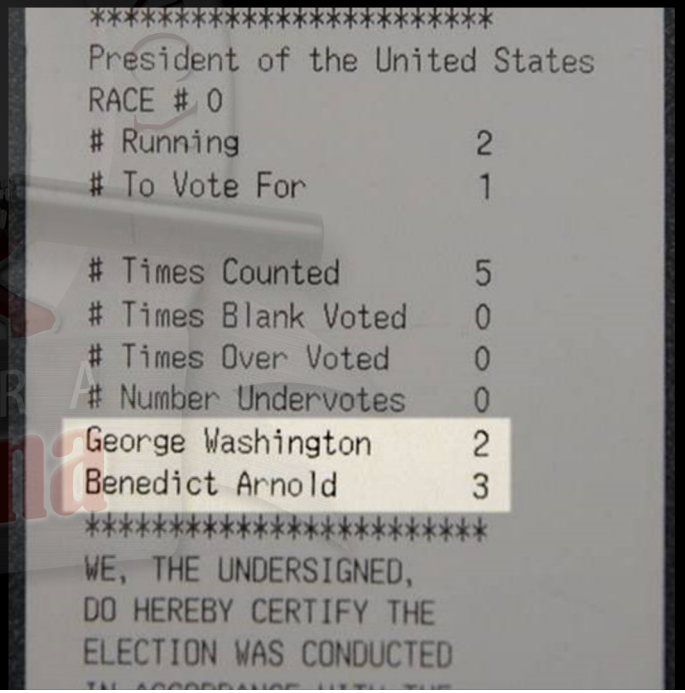
Paper ballot systems: Jurisdictions with 90% of U.S. voters use some combination of hand-marked and BMD paper ballots


President of the United States
George Washington
Framers Party
Benedict Arnold
Redcoat Party
CITIZENS FOR A
New Louisiana


1. Attacker infects memory card containing ballot definition files
Memory Card
GOVERNMENT TRANSPARENCY
CITIZENS FOR A
New Louisiana

2. When officials place the card into the machine, it becomes infected

3. Malware on the machine can change all electronic records and printouts



Centralized **election management system** programs ballot design to memory cards before each election

If infected, can spread malware to machines across entire state

Every U.S. voting machine subjected to rigorous independent security review suffered **vulnerabilities that would enable malware attacks**

Hart InterCivic eSlate
Cards spread malware

AVC Advantage
Cartridges spread malware

Sequoia AVC Edge
Cards spread malware

Optech Insight
Cards spread malware

ES&S iVotronic
Cards spread malware

Diebold AccuVote TSX
Cards spread malware

Diebold AccuVote OS
Cards spread malware

Dominion ICX BMD
USB sticks spread malware

Defending Voting Systems

No credible evidence *any* U.S. election result has ever been hacked.
But, sophisticated attackers have targeted elections before, and will again…

How to achieve security and public trust using imperfect technology?

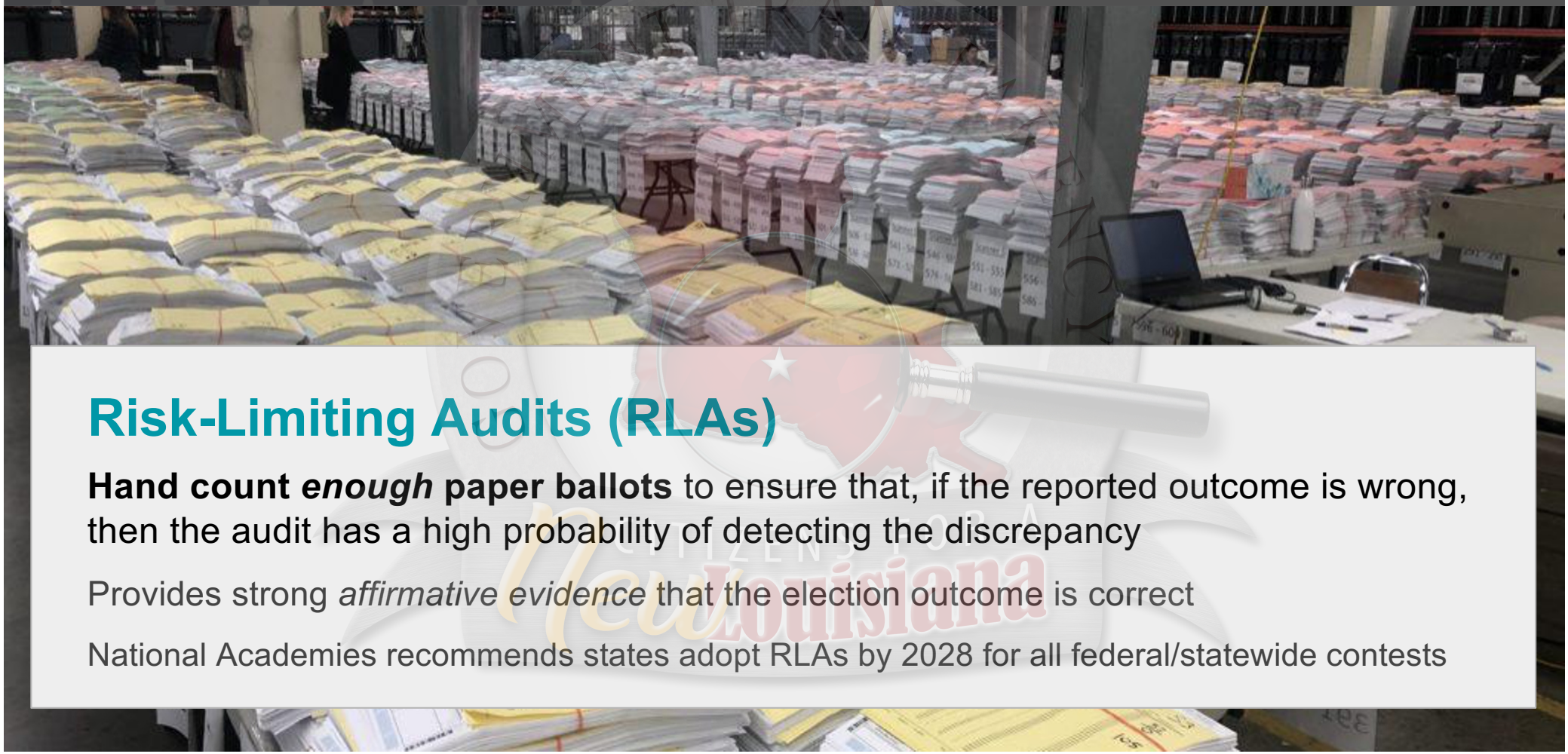
Current approach in Louisiana:
Keep attackers out of the machines.

- La. has experienced security pros and strong IT defense practices
- But with paperless system, can't know *for sure* whether they've succeeded
- At best, no evidence of problems. La.'s next voting system can do better!

Better approach: **Provide public, *affirmative evidence* results are accurate.**

- Can accomplish this with paper ballots plus risk-limiting audits

Using Paper as a Defense



Risk-Limiting Audits (RLAs)

Hand count *enough* paper ballots to ensure that, if the reported outcome is wrong, then the audit has a high probability of detecting the discrepancy

Provides strong *affirmative evidence* that the election outcome is correct

National Academies recommends states adopt RLAs by 2028 for all federal/statewide contests

Hand-Marked Paper Ballots

advantages

HMPBs are the main voting method in **38 states** + used everywhere for absentee

Advantages:

- **Simplest technology, most fail-safe**
- **Same system for in-person, early, and absentee**
- **Voters' marks cannot be altered by hacking**
- ***Highly secure* when used with risk-limiting audits**

Modern precinct scanners make a complete digital record of the ballot with the voter present

Comparing the digital records to the paper ballots can catch *both* old-fashioned and high-tech fraud

Hand-Marked Paper Ballots

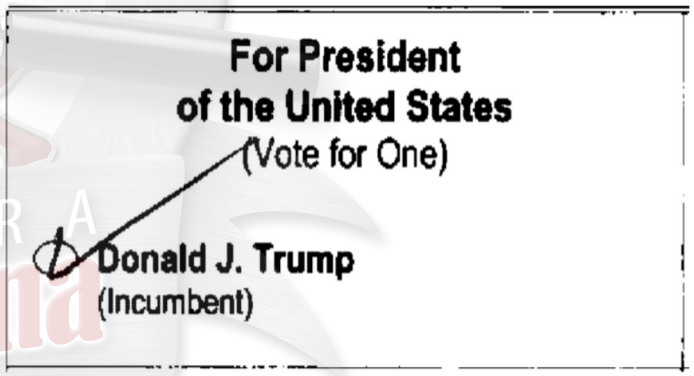
challenges

Ballot printing and chain-of-custody

- Maintain adequate stock of all ballot styles in the precinct.
  On-demand ballot printing widely used for early voting
- Implement procedures to protect ballot transport and storage

Voter errors and ambiguous marks

- Precinct scanners detect common mistakes
  and give voters an opportunity to correct
- "Marginal" marks can be flagged for review
  by bipartisan teams to determine voter intent
- RLAs ensure that any miscounted marks
  don't affect the election outcome



Need a different technology for accessibility

Ballot Marking Devices for Accessibility

advantages

Not all voters can mark ballots by hand. HAVA requires assistive technology

To provide this, most states offer at least one BMD in each polling place

BMDs provide different experiences for voters with different needs:

- Basic touch screen interface
- Large type or high-contrast
- Audio ballot
- Alternative input devices

Marks are unambiguous

Overvotes are not possible

One BMD can handle all ballot styles

Ballot Marking Devices for Accessibility

challenges

Voters with disabilities sometimes face challenges when most voters use HMPBs

Reliability: BMDs improperly set up, malfunctioning, or poll workers unfamiliar

- Must ensure training and testing treat BMDs as essential component
- Elections culture should recognize failure of BMDs as a serious problem

Privacy: When very few voters use BMDs, printed ballots violate voters' privacy

- Instruct poll workers to encourage some voters to use BMDs, so there are at least a minimum number of BMD votes in each precinct

Equality: Some perceive having different voting machines as unequal experience

- Even w/ BMDs for all, voters with different needs experience voting differently
- Prioritize ensuring everyone's needs are well served, with a range of assistive options, such as curb-side voting and online marking for absentee postal ballots

Universal-Use BMDs?

security risks

A few states use BMDs for *every in-person voter*. **Universal-use BMDs introduce major security challenges.**

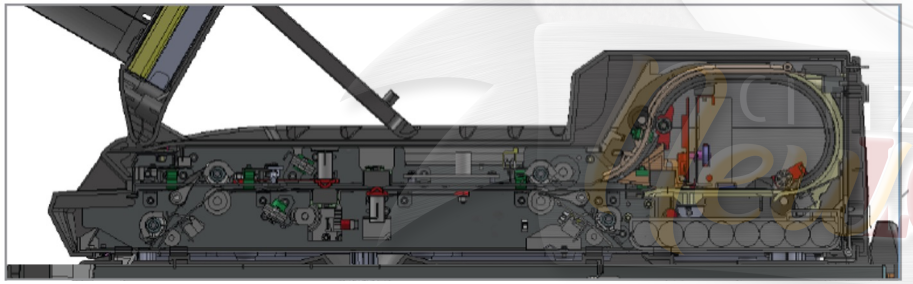
- **BMDs ≠ pens.** A vulnerable computer sits between the voter and their paper ballot
- **If hacked, can misprint or alter votes.**
  Some errors, voters can't detect.
  Others, voters don't reliably detect.
  If the paper ballots are wrong, RLAs don't help!
- When used by all, BMDs are a large, attractive target, making attacks more likely
- When there's no RLA or recount, risks may be higher than with DREs: *Two* machines (BMD or scanner), either of which might be hacked…

BMD Options that Increase Risk

All-in-One BMDs

Some systems combine BMD, printer, and scanner into a single device

If the printer is on the same paper-path as the scanner, a hacked BMD could potentially alter the paper ballot *after* the voter sees it



BMD cross-section illustrating paper path

Barcode Ballots

Some systems count BMD barcodes instead of ballot text

A hacked BMD could change the votes in the barcodes, and voters would have no way to tell

For President of the United States (Vote for One) (DEM)
Vote for Joseph R. Biden

For United States Senate (Vote for One) (DEM)
Vote for Jon Ossoff

For Public Service Commissioner (Vote for One) (DEM)
Vote for Robert G. Bryant

For Public Service Commissioner (Vote for One) (DEM)
Vote for Daniel Blackman

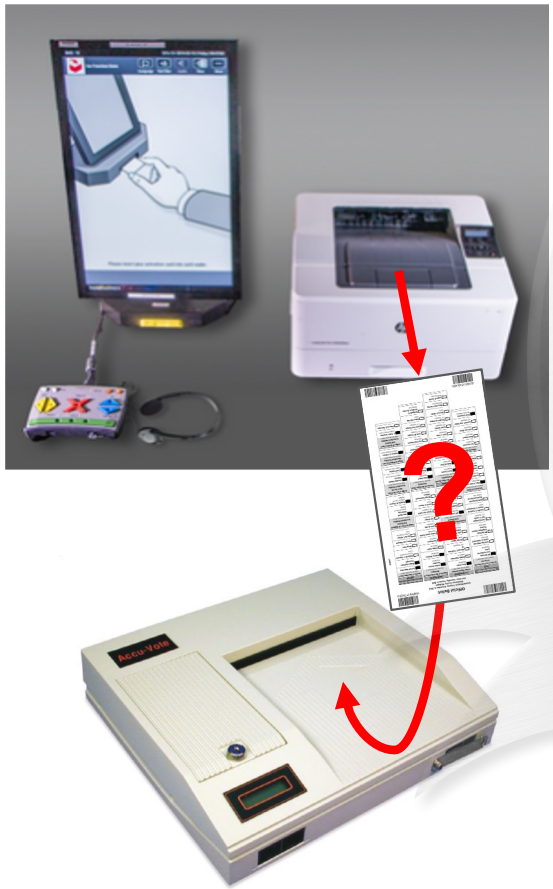
For U.S. Representative in 117th Congress From the 3rd Congressional District of Georgia (Vote for One) (DEM)
Vote for Val Almonord

For State Senator From 34th District (Vote for One) (DEM)
Vote for Valencia M. Seay (I)

For State Representative In the General Assembly From 64th District (Vote for One) (DEM)
Vote for Derrick L. Jackson (I)

RLA of the printed text can prevent barcode attacks from altering election outcomes, but can't protect individual voters from disenfranchisement

Voters Don't Reliably Verify BMD Ballots



Threat: Even without barcodes, hacked BMDs could sometimes print different choices than voters select

(Can't reliably test for this. Too many factors could trigger the cheating)

- **Voters do not reliably spot errors on BMD printouts**
  We ran a mock election with hacked BMDs. Voters reported <7% of errors. In a contest with 0.5% margin and universal BMDs, hacking could change outcome with only *one error reported per 5000 voters*
- **Steps to encourage verification can help, but likely not enough**
  In Nov. 2020 in Georgia, only 19% of voters spent >5 seconds reviewing their ballots (0.2 seconds per contest), despite poll worker instructions. About half of voters only glanced at their ballots, or didn't look at all
- **Using BMDs for accessibility is safer than using them for all**
  Attackers would need to change much larger fraction of BMD votes, making detection more likely and deterring attacks in the first place

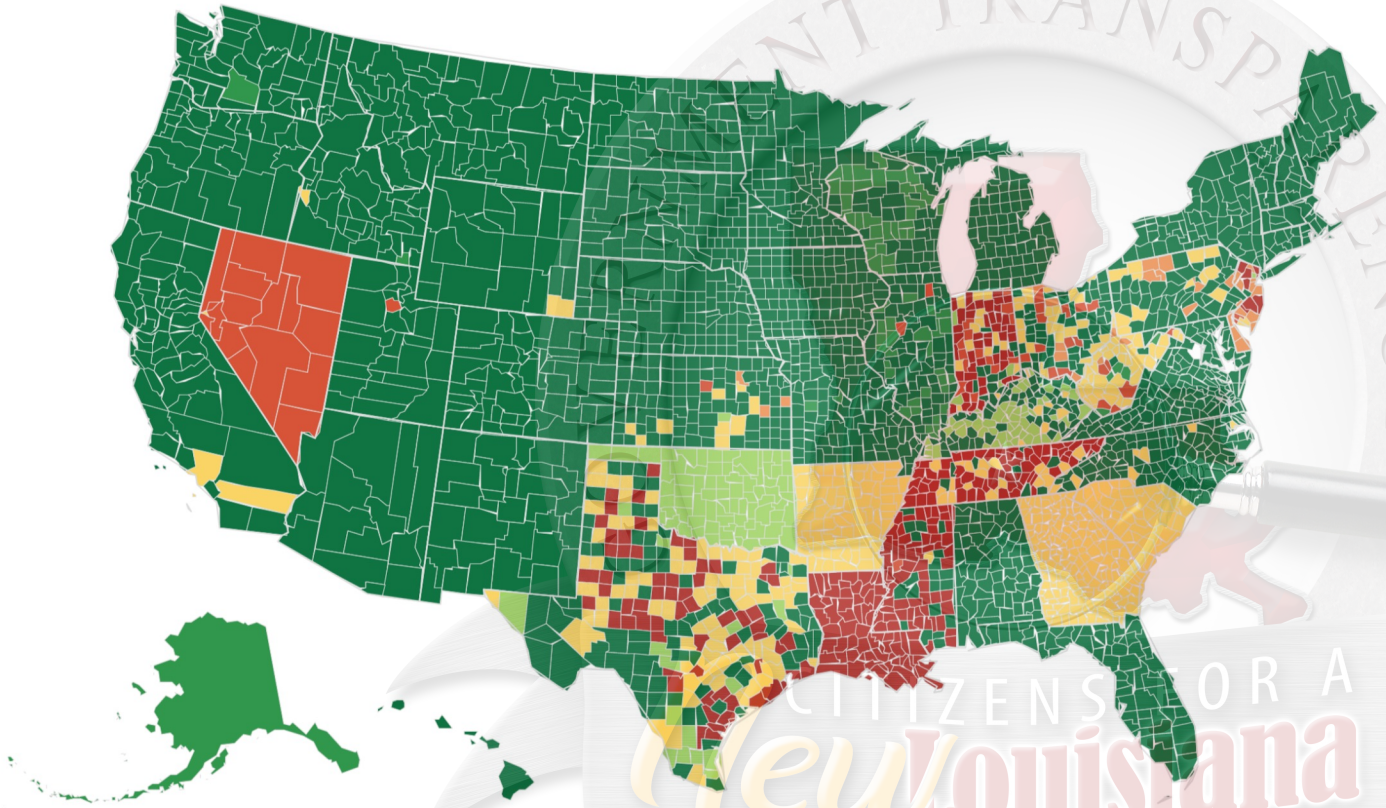
Universal-Use BMDs Limit Trust in Close Elections

Hypothetical scenario, with Universal-Use BMDs:
Contentious statewide contest, decided by a few thousand votes.
A few hundred voters claim their BMDs initially printed the wrong choice.

What is the state supposed to do?

- **Consistent with BMDs being hacked and changing the outcome**
  If so, only way to correct the problem is to re-run the election
- **An attack might leave no obvious digital traces**
  Forensic investigation would be slow, expensive, and likely inconclusive
- **Also consistent with complaints being false (or voter error)**
  No good way to resolve and restore public confidence

The National View



Polling Place Equipment
November 2022

- Hand marked paper ballots, with BMDs for accessibility
- Hand marked paper ballots, with DREs with VVPAT for accessibility
- Hand marked paper ballots, with DREs without VVPAT for accessibility
- Ballot Marking Devices for all voters
- Hybrid BMD/Tabulator
- DREs with VVPAT for all voters
- DREs without VVPAT for all voters

VerifiedVoting

Source: https://verifiedvoting.org/verifier/

69.7%

Percentage of registered voters living in jurisdictions using Hand Marked Paper Ballots for most voters

21.8%

Percentage of registered voters living in jurisdictions using Ballot Marking Devices for all voters

8.5%

Percentage of registered voters living in jurisdictions using Direct Recording Electronic (DRE) Systems for all voters

Louisiana's Opportunity:

Becoming a National Leader in Trustworthy Elections

Last state in the country to use paperless voting statewide,
but great people, strong foundations, and a pivotal moment…

- **Transition to a secure, primarily hand-marked voting system, with state-of-the-art assistive technology for those who need it.**
- **Continue to safeguard computer components with IT best practices.**
- **Implement best-in-class RLAs to provide *affirmative evidence.***

Draw on experience from states that have transitioned to hand-marked paper in the last decade: CA, KY, MD, NY, PA, UT, VA, and more.

Your chance to create elections that work for everyone, and that everybody can have confidence in.

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