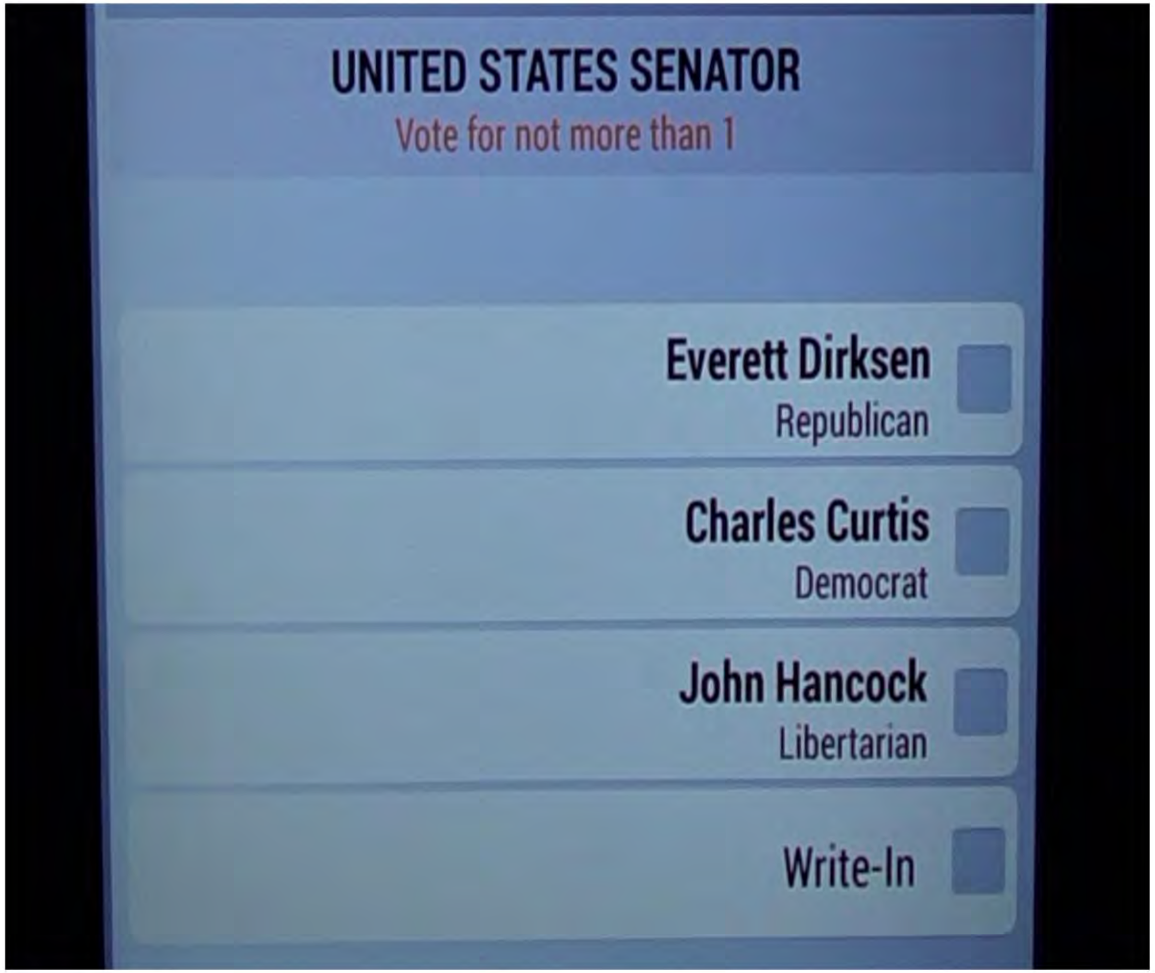
Dominion Touchscreen: Simple Hacks and Daunting Recoveries

Phillip Davis, Marilyn Marks, & Drew Springall

Dominion Touchscreen ICX



UNITED STATES SENATOR

Vote for not more than 1

Everett Dirksen □
Republican

Charles Curtis □
Democrat

John Hancock □
Libertarian

Write-In □

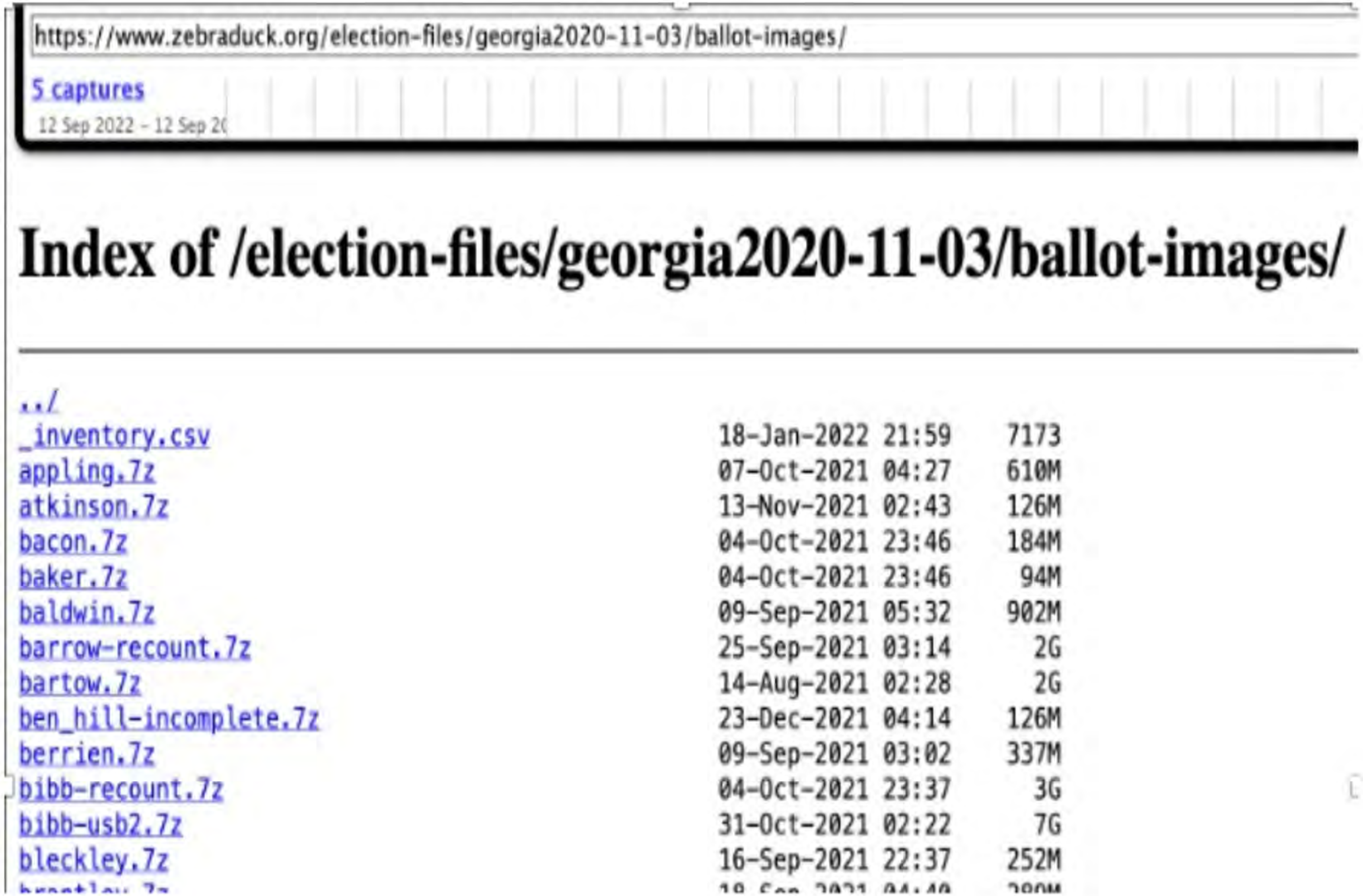
Simple Election Database Hacks

Hack the **Voter**
or
Hack the **Vote Count**

Davis Found 5 Counties’ Restricted Data on Public Site

Restricted GA Election Databases posted from-

- Appling County
- Bibb County
- Jones County
- Pulaski County
- Telfair County



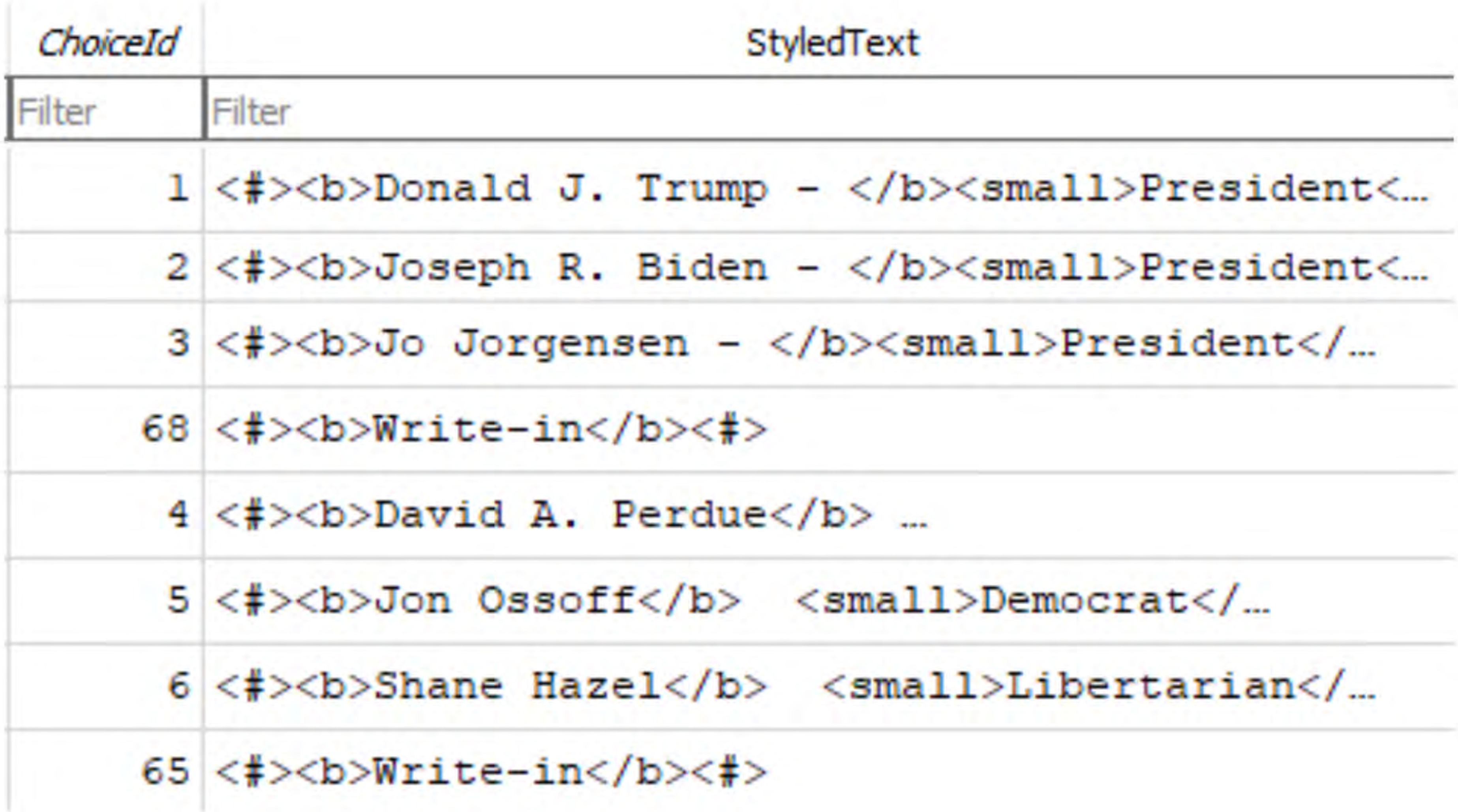
https://www.zebraduck.org/election-files/georgia2020-11-03/ballot-images/

5 captures
12 Sep 2022 - 12 Sep 20

Index of /election-files/georgia2020-11-03/ballot-images/

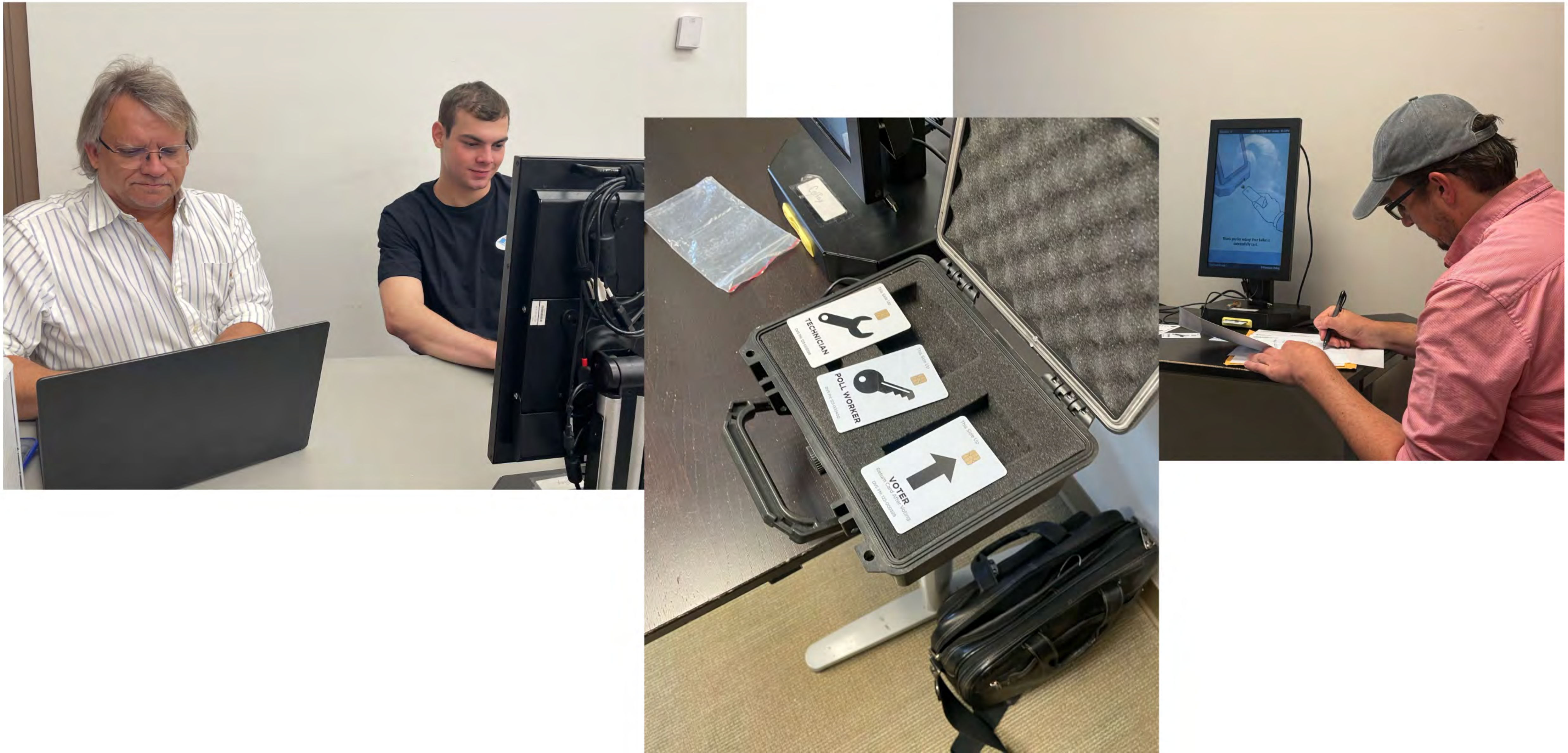
```
../
_inventory.csv                                   18-Jan-2022 21:59    7173
appling.7z                                       07-Oct-2021 04:27    610M
atkinson.7z                                      13-Nov-2021 02:43    126M
bacon.7z                                         04-Oct-2021 23:46    184M
baker.7z                                         04-Oct-2021 23:46     94M
baldwin.7z                                       09-Sep-2021 05:32    902M
barrow-recount.7z                                25-Sep-2021 03:14      2G
bartow.7z                                        14-Aug-2021 02:28      2G
ben_hill-incomplete.7z                           23-Dec-2021 04:14    126M
berrien.7z                                       09-Sep-2021 03:02    337M
bibb-recount.7z                                  04-Oct-2021 23:37      3G
bibb-usb2.7z                                     31-Oct-2021 02:22      7G
bleckley.7z                                      16-Sep-2021 22:37    252M
brantley.7z                                      18-Sep-2021 04:40    280M
```

Davis Learns SQLite DB Easily Accessed and Modified

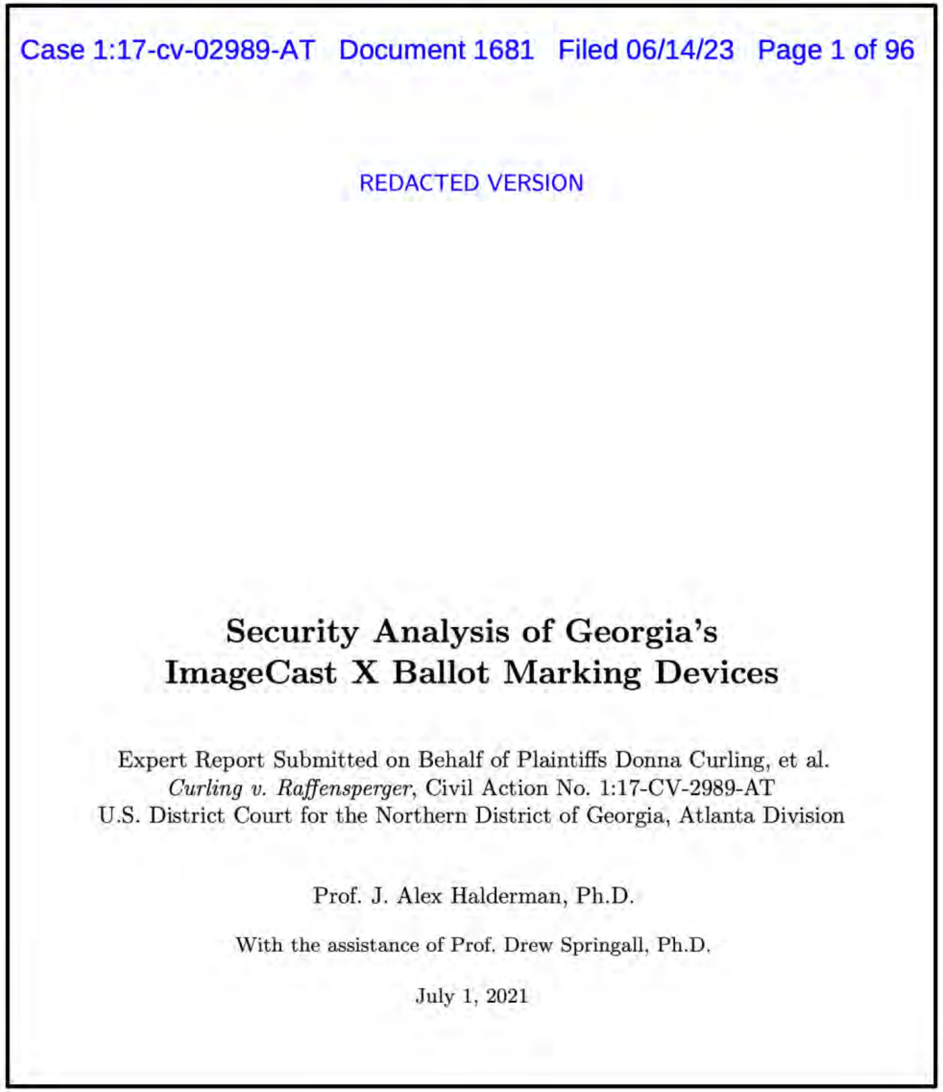


ChoiceId	StyledText
Filter	Filter
1	<#><b>Donald J. Trump - </b><small>President<…
2	<#><b>Joseph R. Biden - </b><small>President<…
3	<#><b>Jo Jorgensen - </b><small>President</…
68	<#><b>Write-in</b><#>
4	<#><b>David A. Perdue</b> …
5	<#><b>Jon Ossoff</b> <small>Democrat</…
6	<#><b>Shane Hazel</b> <small>Libertarian</…
65	<#><b>Write-in</b><#>

Hacked over a weekend three weeks ago



Previous Findings (GA, DemSuite 5.5-A)



Case 1:17-cv-02989-AT Document 1681 Filed 06/14/23 Page 1 of 96

REDACTED VERSION

Security Analysis of Georgia's ImageCast X Ballot Marking Devices

Expert Report Submitted on Behalf of Plaintiffs Donna Curling, et al.
Curling v. Raffensperger, Civil Action No. 1:17-CV-2989-AT
U.S. District Court for the Northern District of Georgia, Atlanta Division

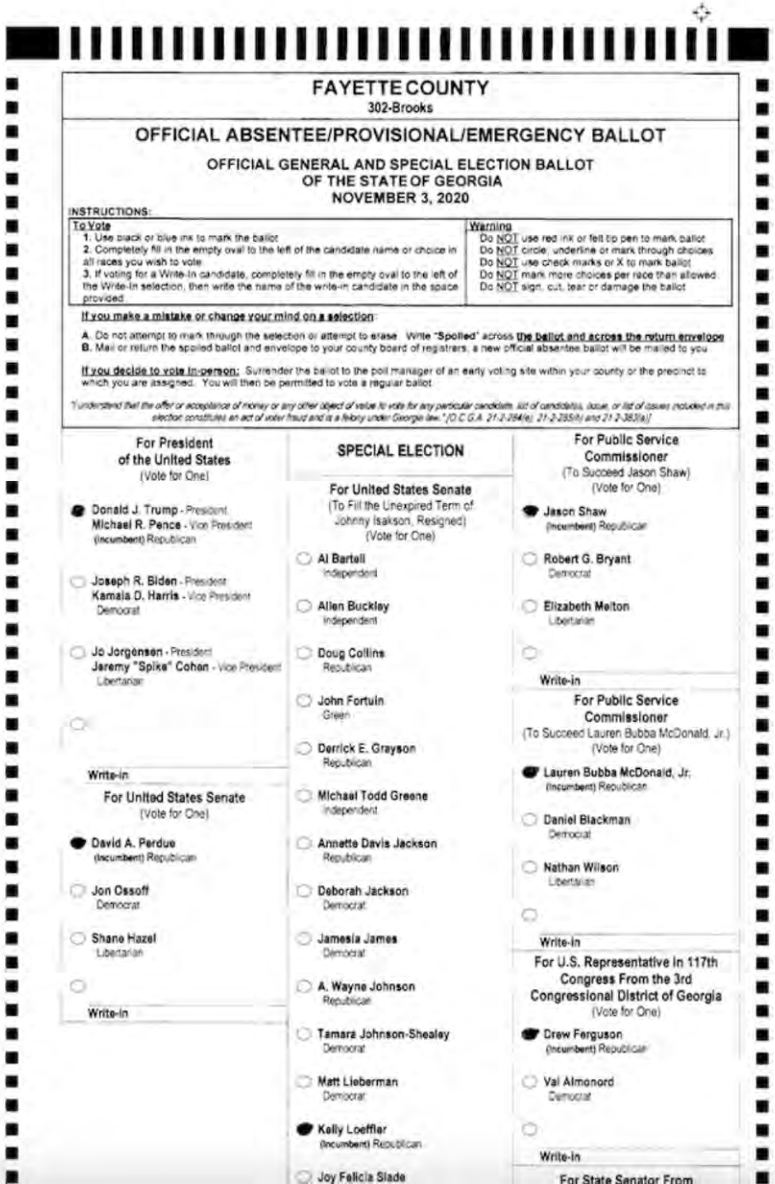
Prof. J. Alex Halderman, Ph.D.

With the assistance of Prof. Drew Springall, Ph.D.

July 1, 2021

- Court-ordered access to ICX and precinct scanner (ICP)
- Protective order
- Multiple vulnerabilities found
  - Validated by CISA
  - ”Bottom Up” hacks proven
  - Hear more in Session 2

Hand Marked Ballots are Standard



FAYETTE COUNTY
302-Brooks

OFFICIAL ABSENTEE/PROVISIONAL/EMERGENCY BALLOT

OFFICIAL GENERAL AND SPECIAL ELECTION BALLOT
OF THE STATE OF GEORGIA
NOVEMBER 3, 2020

INSTRUCTIONS:

To Vote

1. Use black or blue ink to mark the ballot
2. Completely fill in the empty oval to the left of the candidate name or choice in all races you wish to vote
3. If voting for a Write-in candidate, completely fill in the empty oval to the left of the Write-in selection, then write the name of the write-in candidate in the space provided

Warning

Do NOT use red ink or felt tip pen to mark ballot
Do NOT circle, underline or mark through choices
Do NOT use check marks or X to mark ballot
Do NOT mark more choices per race than allowed
Do NOT sign, cut, tear or damage the ballot

If you make a mistake or change your mind on a selection:

A. Do not attempt to mark through the selection or attempt to erase. Write "Spoiled" across **the ballot and across the return envelope**
B. Mail or return the spoiled ballot and envelope to your county board of registrars, a new official absentee ballot will be mailed to you

If you decide to vote in-person: Surrender the ballot to the poll manager of an early voting site within your county or the precinct to which you are assigned. You will then be permitted to vote a regular ballot

"I understand that the offer or acceptance of money or any other object of value to vote for any particular candidate, list of candidates, issue, or list of issues included in this election constitutes an act of voter fraud and is a felony under Georgia law." (O.C.G.A. 21-2-284(e), 21-2-285(h) and 21-2-383(a))

For President
of the United States
(Vote for One)

● Donald J. Trump - President
Michael R. Pence - Vice President
(Incumbent) Republican

○ Joseph R. Biden - President
Kamala D. Harris - Vice President
Democrat

○ Jo Jorgensen - President
Jeremy "Spike" Cohen - Vice President
Libertarian

○
Write-in

For United States Senate
(Vote for One)

● David A. Perdue
(Incumbent) Republican

○ Jon Ossoff
Democrat

○ Shane Hazel
Libertarian

○
Write-in

SPECIAL ELECTION

For United States Senate
(To Fill the Unexpired Term of
Johnny Isakson, Resigned)
(Vote for One)

○ Al Bartell
Independent

○ Allen Buckley
Independent

○ Doug Collins
Republican

○ John Fortuin
Green

○ Derrick E. Grayson
Republican

○ Michael Todd Greene
Independent

○ Annette Davis Jackson
Republican

○ Deborah Jackson
Democrat

○ Jamesia James
Democrat

○ A. Wayne Johnson
Republican

○ Tamara Johnson-Shealey
Democrat

○ Matt Lieberman
Democrat

● Kelly Loeffler
(Incumbent) Republican

○ Joy Felicia Slade

For Public Service
Commissioner
(To Succeed Jason Shaw)
(Vote for One)

● Jason Shaw
(Incumbent) Republican

○ Robert G. Bryant
Democrat

○ Elizabeth Melton
Libertarian

○
Write-in

For Public Service
Commissioner
(To Succeed Lauren Bubba McDonald, Jr.)
(Vote for One)

● Lauren Bubba McDonald, Jr.
(Incumbent) Republican

○ Daniel Blackman
Democrat

○ Nathan Wilson
Libertarian

○
Write-in

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

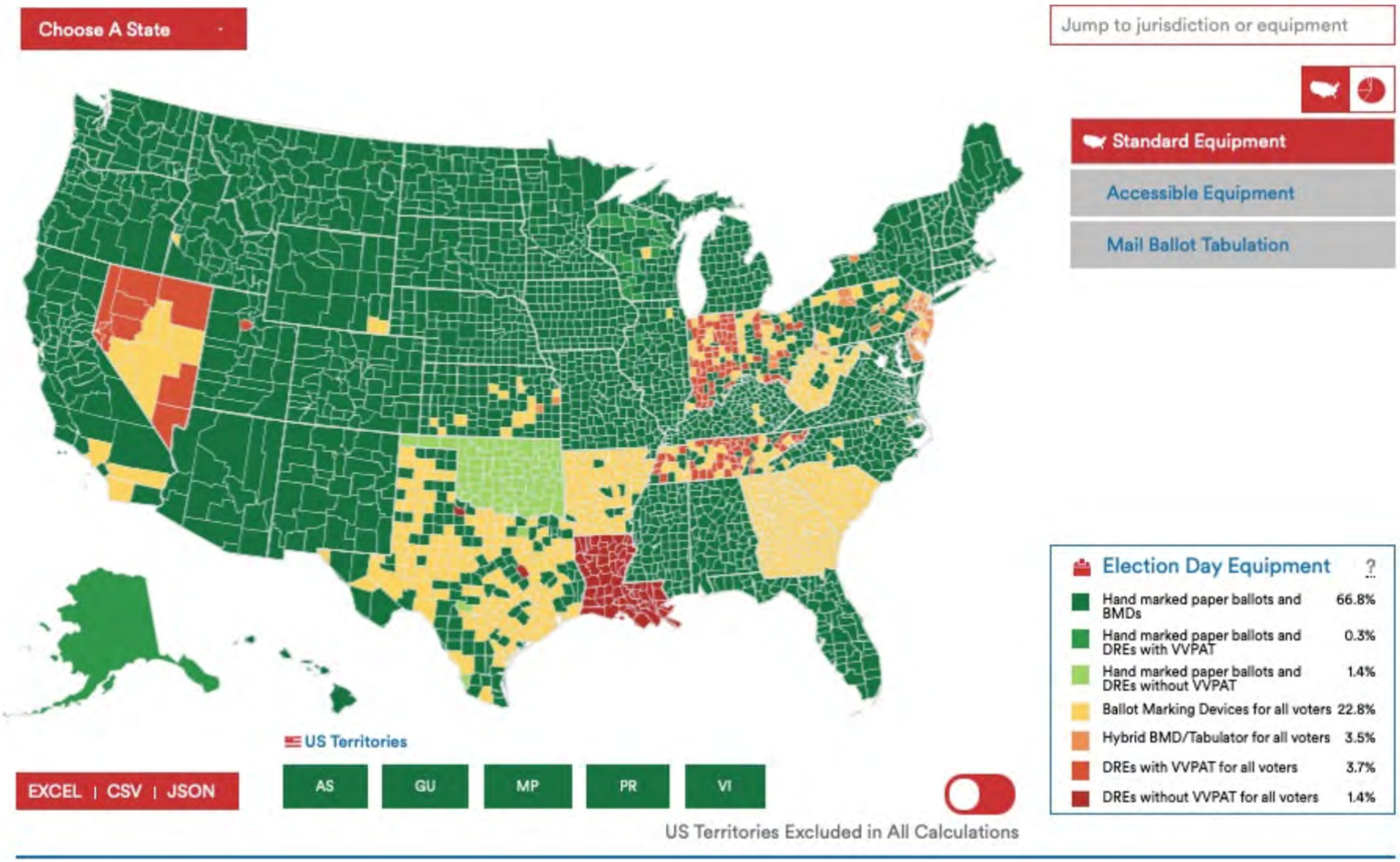
● Drew Ferguson
(Incumbent) Republican

○ Val Almonord
Democrat

○
Write-in

For State Senator From

Hand Marked Ballots with Tabulator are Standard



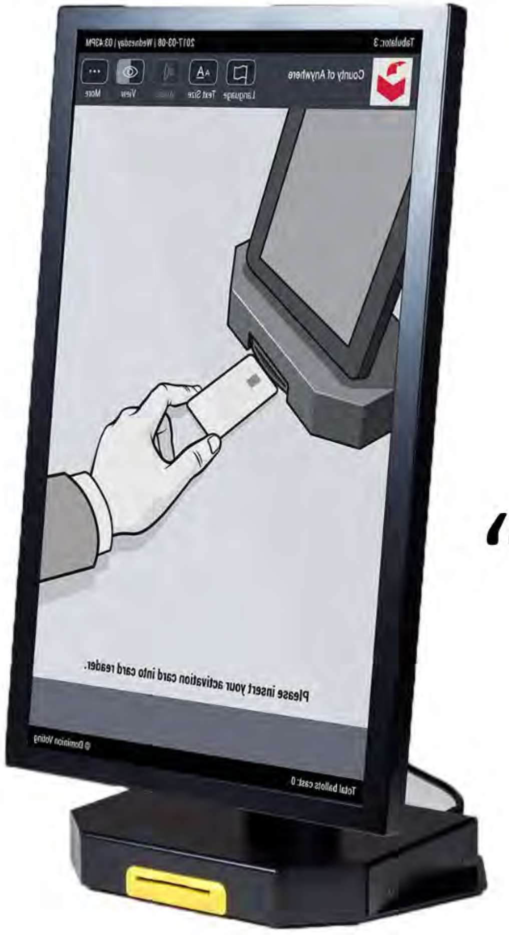
US Territories Excluded in All Calculations

Election Day Equipment ?

🟩	Hand marked paper ballots and BMDs	66.8%
🟩	Hand marked paper ballots and DREs with VVPAT	0.3%
🟩	Hand marked paper ballots and DREs without VVPAT	1.4%
🟨	Ballot Marking Devices for all voters	22.8%
🟧	Hybrid BMD/Tabulator for all voters	3.5%
🟧	DREs with VVPAT for all voters	3.7%
🟥	DREs without VVPAT for all voters	1.4%

Dominion Touchscreen

“ICX”

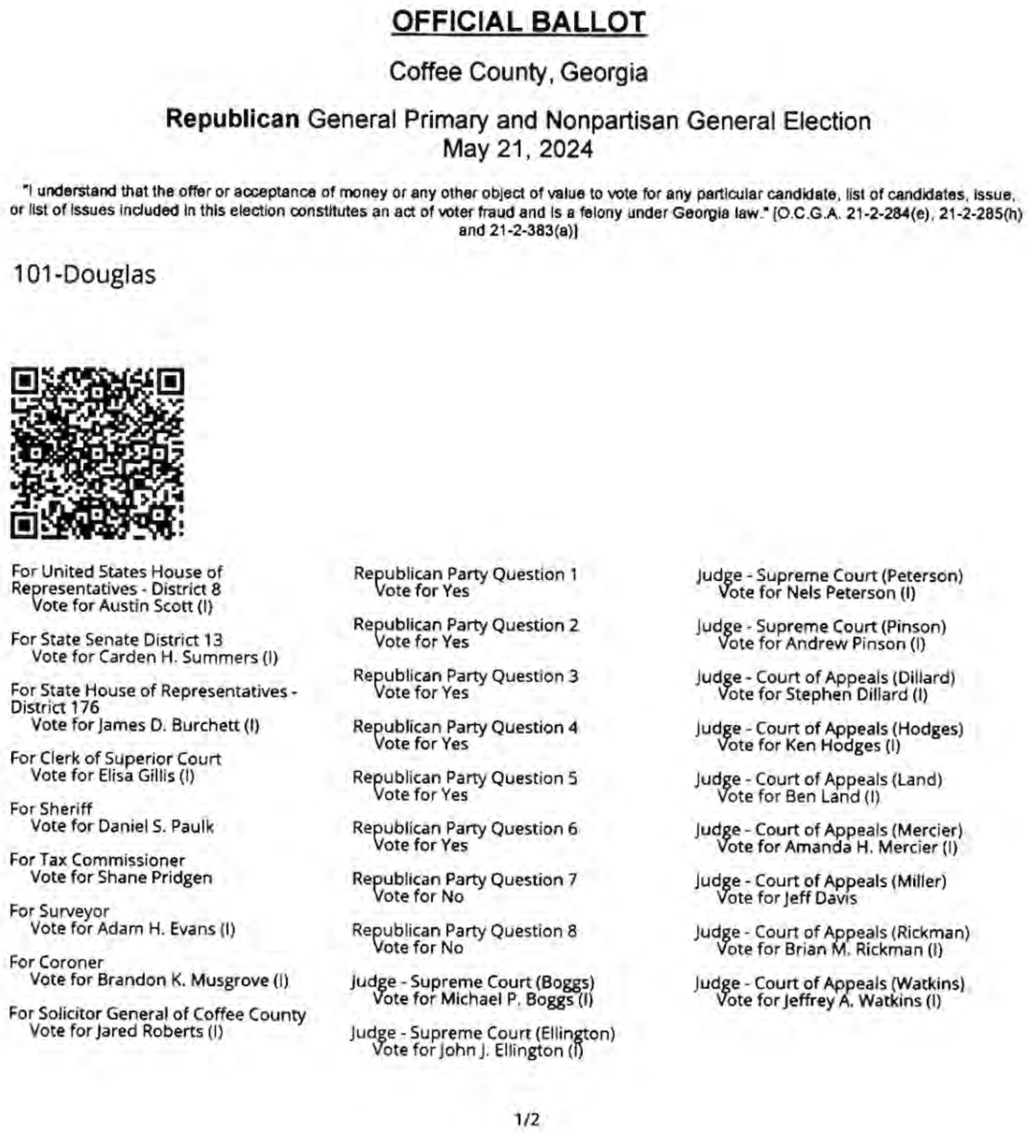


“BMD”

“ImageCast X”

“Ballot Marking Device”

ICX Printed Ballot Ready for Scanning



OFFICIAL BALLOT

Coffee County, Georgia

Republican General Primary and Nonpartisan General Election
May 21, 2024

"I understand that the offer or acceptance of money or any other object of value to vote for any particular candidate, list of candidates, issue, or list of issues included in this election constitutes an act of voter fraud and is a felony under Georgia law." (O.C.G.A. 21-2-284(e), 21-2-285(h) and 21-2-383(a))

101-Douglas

For United States House of Representatives - District 8
Vote for Austin Scott (I)

For State Senate District 13
Vote for Carden H. Summers (I)

For State House of Representatives - District 176
Vote for James D. Burchett (I)

For Clerk of Superior Court
Vote for Elisa Gillis (I)

For Sheriff
Vote for Daniel S. Paulk

For Tax Commissioner
Vote for Shane Pridgen

For Surveyor
Vote for Adam H. Evans (I)

For Coroner
Vote for Brandon K. Musgrove (I)

For Solicitor General of Coffee County
Vote for Jared Roberts (I)

Republican Party Question 1
Vote for Yes

Republican Party Question 2
Vote for Yes

Republican Party Question 3
Vote for Yes

Republican Party Question 4
Vote for Yes

Republican Party Question 5
Vote for Yes

Republican Party Question 6
Vote for Yes

Republican Party Question 7
Vote for No

Republican Party Question 8
Vote for No

Judge - Supreme Court (Boggs)
Vote for Michael P. Boggs (I)

Judge - Supreme Court (Ellington)
Vote for John J. Ellington (I)

Judge - Supreme Court (Peterson)
Vote for Nels Peterson (I)

Judge - Supreme Court (Pinson)
Vote for Andrew Pinson (I)

Judge - Court of Appeals (Dillard)
Vote for Stephen Dillard (I)

Judge - Court of Appeals (Hodges)
Vote for Ken Hodges (I)

Judge - Court of Appeals (Land)
Vote for Ben Land (I)

Judge - Court of Appeals (Mercier)
Vote for Amanda H. Mercier (I)

Judge - Court of Appeals (Miller)
Vote for Jeff Davis

Judge - Court of Appeals (Rickman)
Vote for Brian M. Rickman (I)

Judge - Court of Appeals (Watkins)
Vote for Jeffrey A. Watkins (I)

1/2

Democracy Suite Voting System

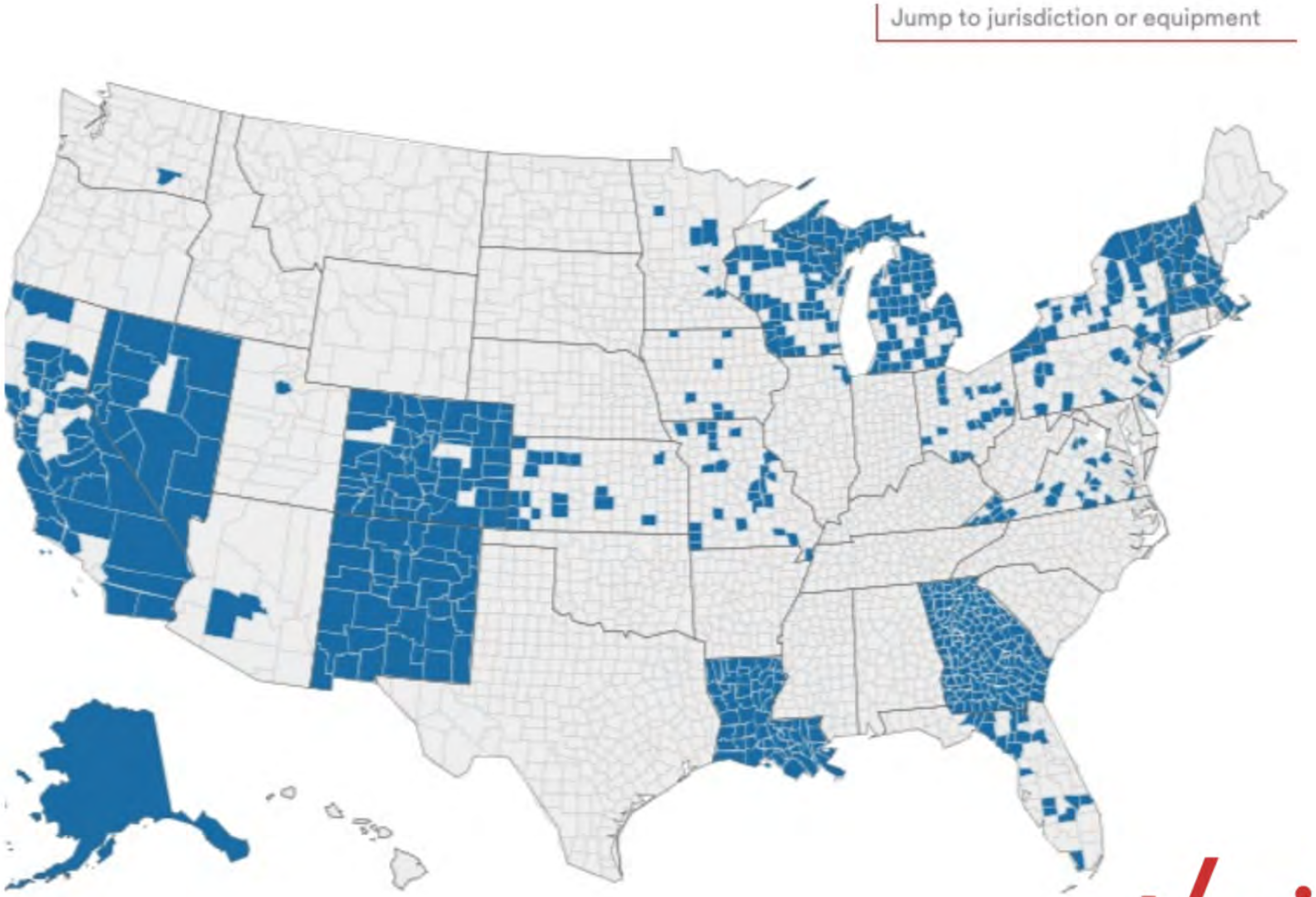
EMS Server

ICX

ICP
Scanner

EMS Server

Dominion System Usage



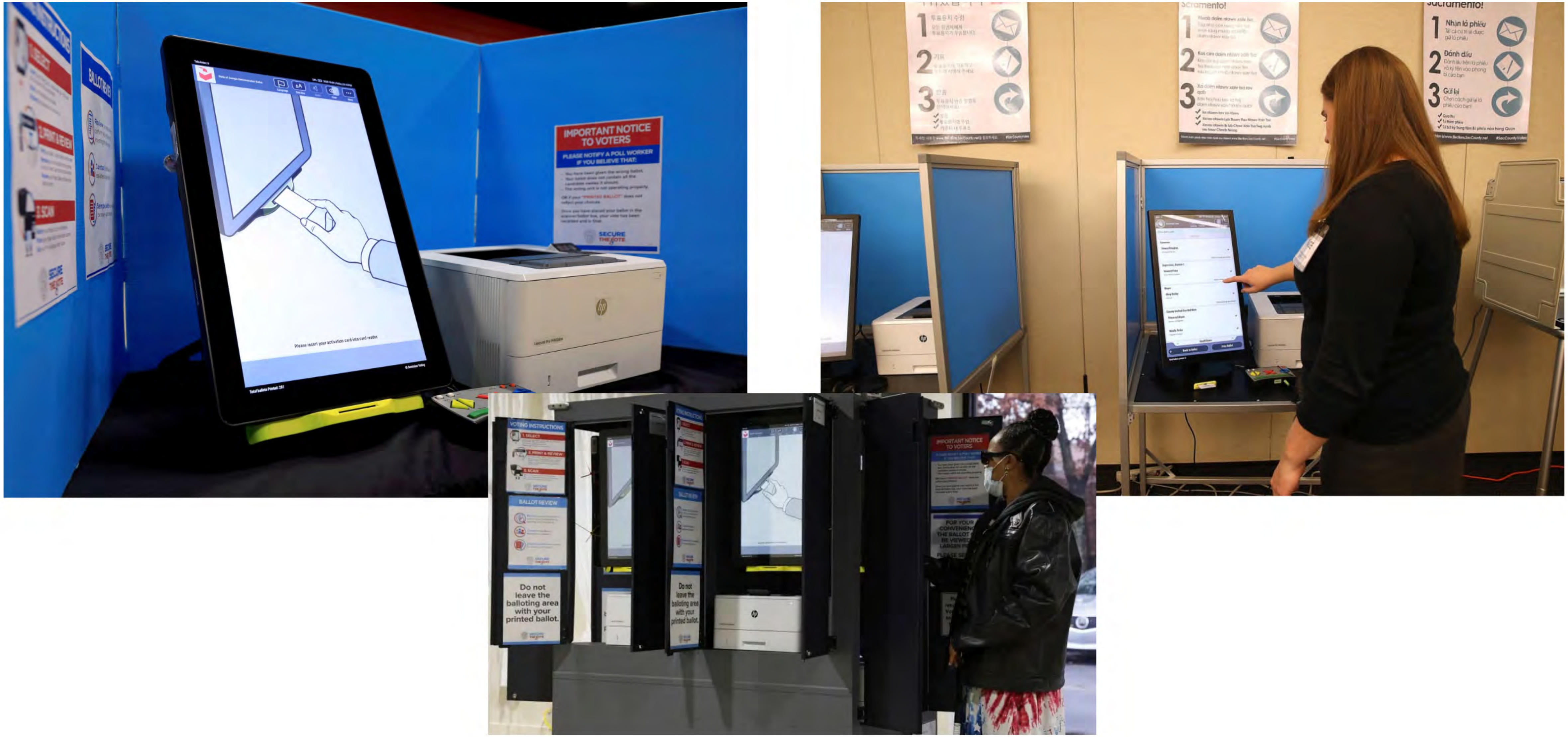
VerifiedVoting

40,000 ICX Touchscreens in GA

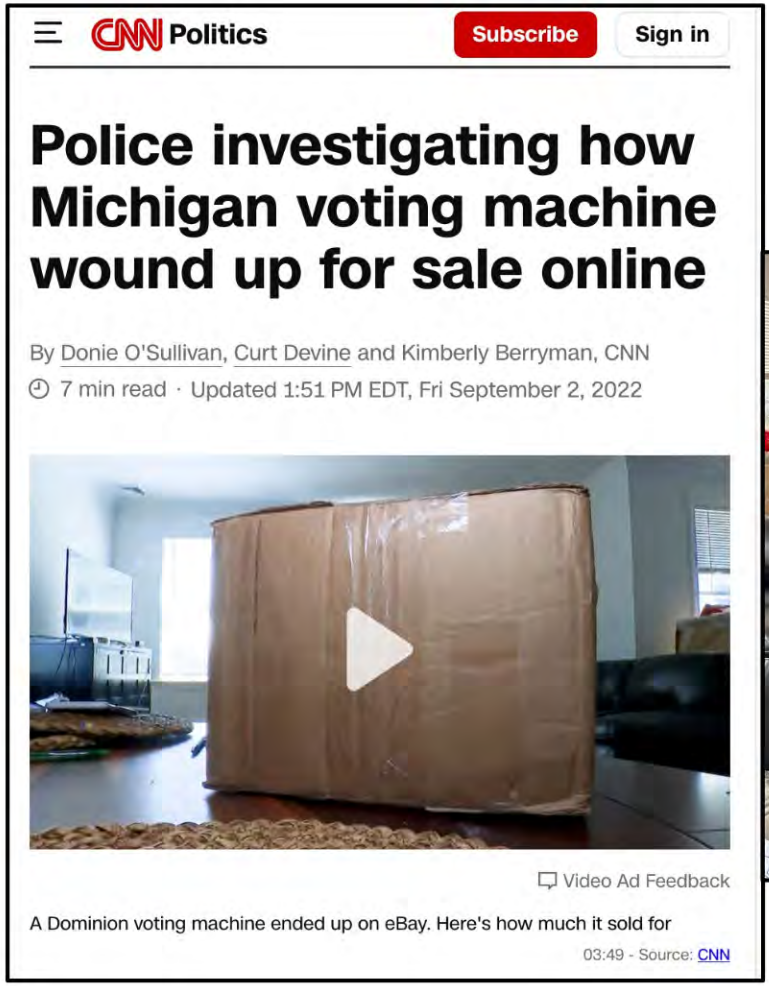
- Big COTS Touchscreen with App
- Printer creates record
- Select the Mayor or Senator

- Big COTS Touchscreen with App
- Printer creates record
- Select Big Mac or Milkshake

ICX Deployment


IMPORTANT NOTICE TO VOTERS
PLEASE NOTIFY A POLL WORKER IF YOU BELIEVE THAT:
SECURE THE VOTE
Please insert your activation card into card reader
VOTING INSTRUCTIONS
1. SELECT
2. PRINT & REVIEW
3. SCAN
BALLOT REVIEW
Do not leave the balloting area with your printed ballot.
Nhận lá phiếu
Đánh dấu
Gửi lại

ICX Used for Demonstration



Police investigating how Michigan voting machine wound up for sale online

By Donie O'Sullivan, Curt Devine and Kimberly Berryman, CNN

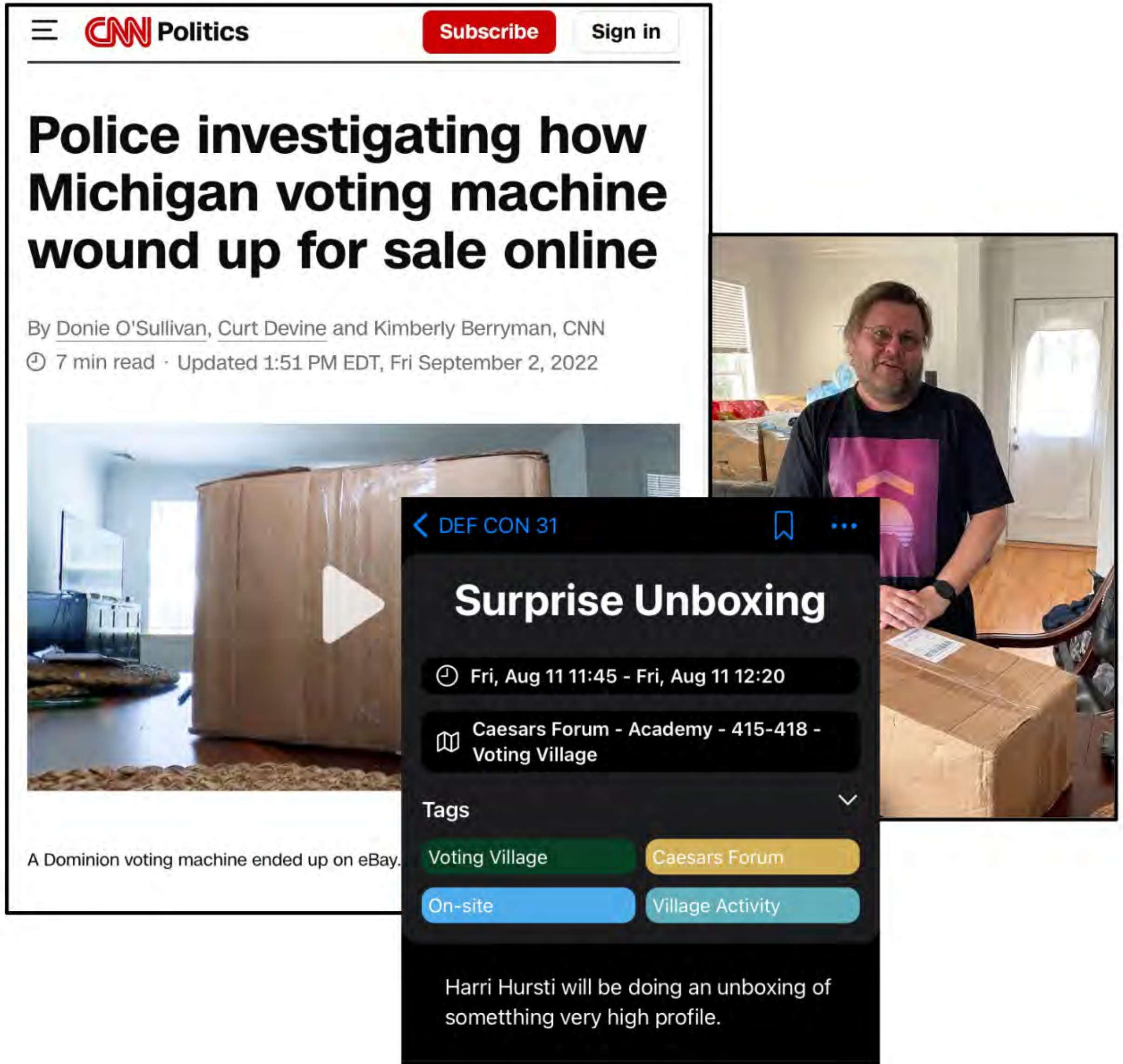
7 min read · Updated 1:51 PM EDT, Fri September 2, 2022

A Dominion voting machine ended up on eBay. Here's how much it sold for

03:49 - Source: CNN

- Bought by Harri Hursti in 2022
  - Traced back to Colfax Township, MI

ICX Used for Demonstration



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Surprise Unboxing

Fri, Aug 11 11:45 - Fri, Aug 11 12:20

Caesars Forum - Academy - 415-418 - Voting Village

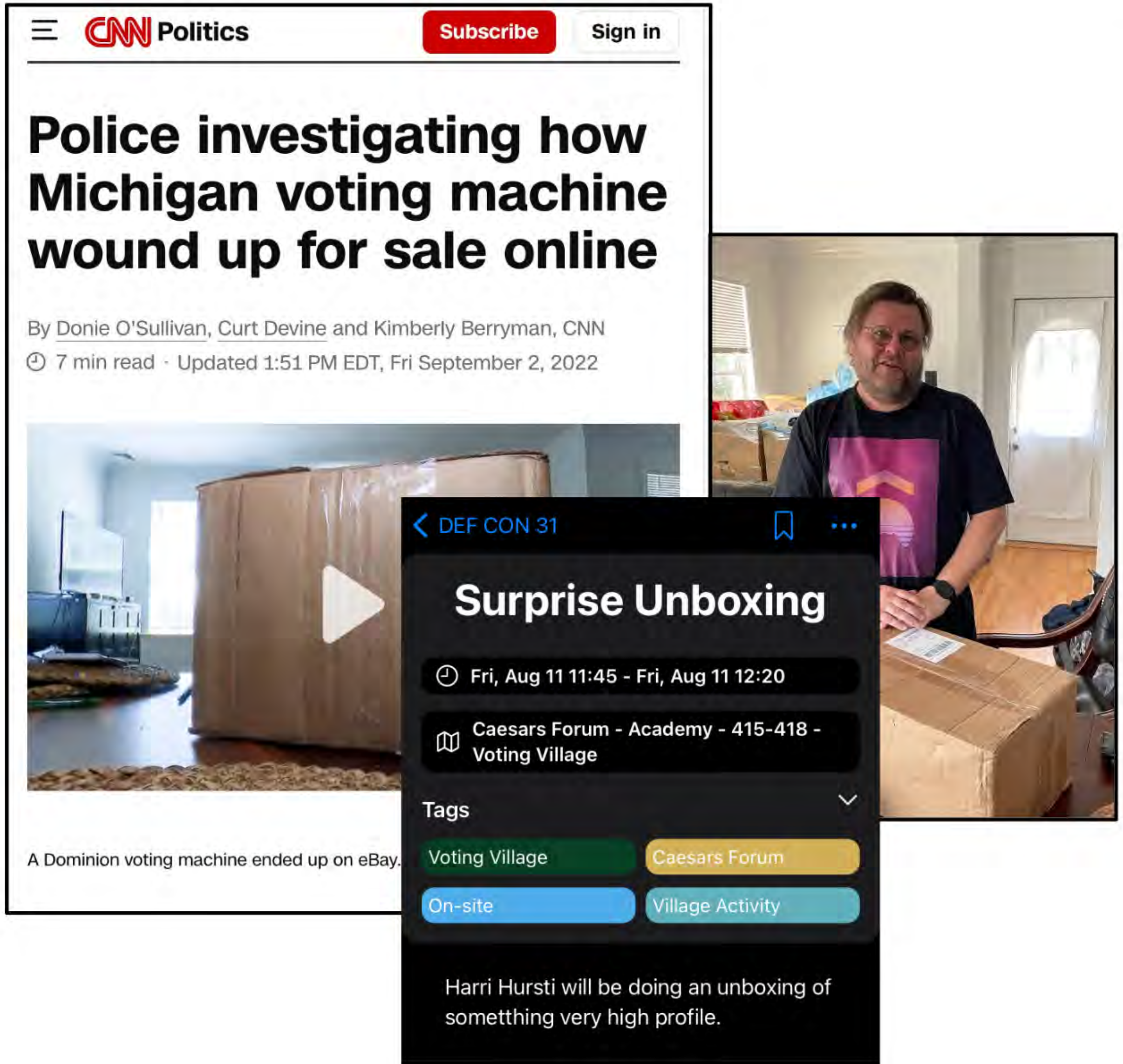
Tags

Voting Village · Caesars Forum · On-site · Village Activity

Harri Hursti will be doing an unboxing of somethting very high profile.

- Bought by Harri Hursti in 2022
  - Traced back to Colfax Township, MI
- Debuted at Voting Village 2023

ICX Used for Demonstration



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Tags

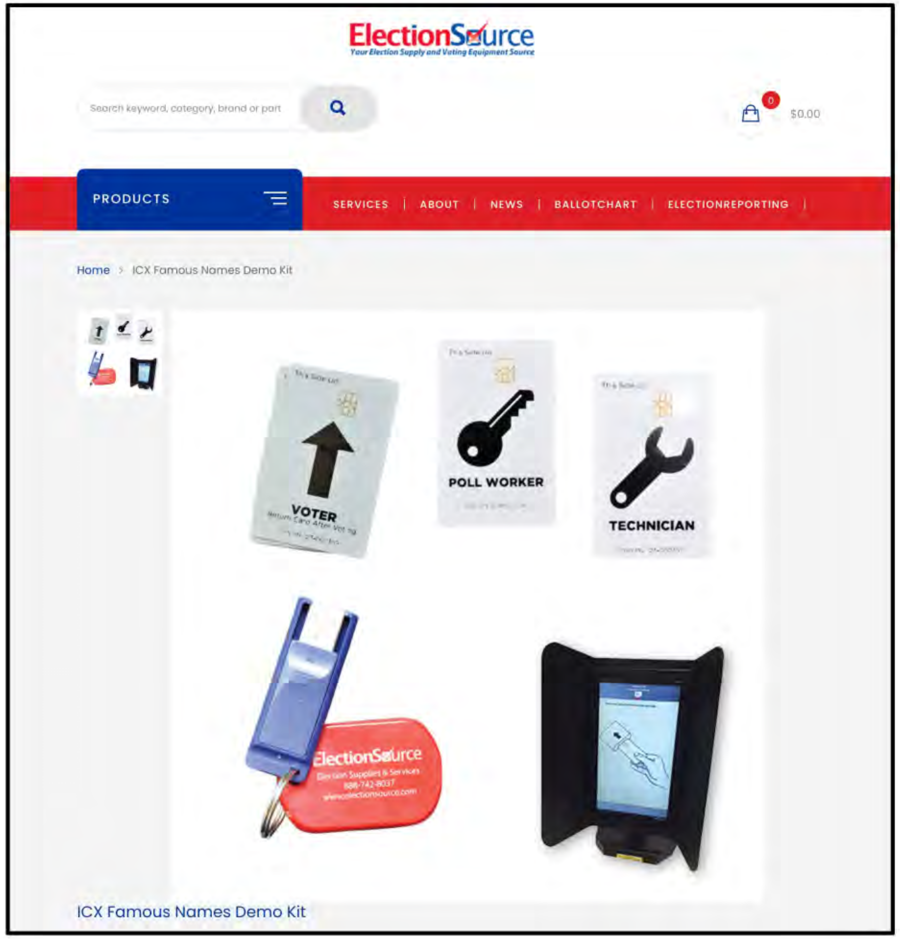
Voting Village | Caesars Forum | On-site | Village Activity

Harri Hursti will be doing an unboxing of somethting very high profile.

- Bought by Harri Hursti in 2022
  - Traced back to Colfax Township, MI
- Debuted at Voting Village 2023
- COTS Android tablet (Avalue Technologies SID-15V)
  - Underlying OS: Android 4 OS
  - Voting System: DVS DemSuite 5.5
  - ICX App: v5.5.10.25

Famous Names Demo Kit Used

Famous Names Demo Kit Used



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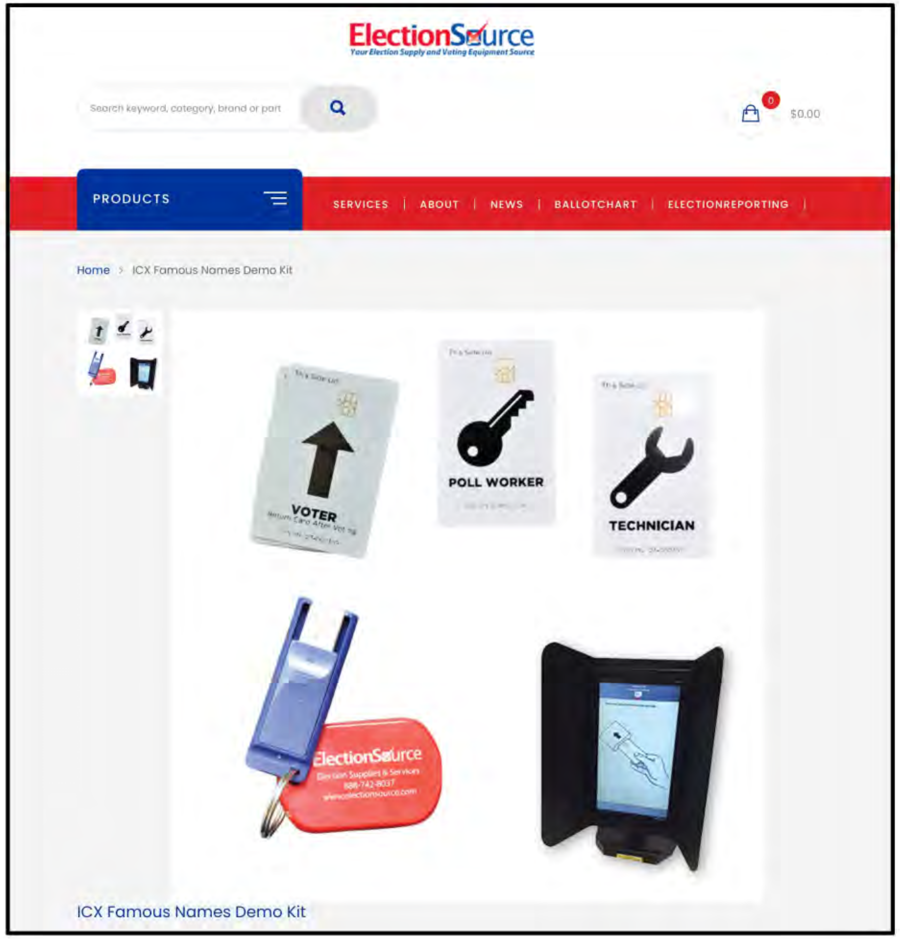
ICX Famous Names Demo Kit

Famous Names Demo Kit Used



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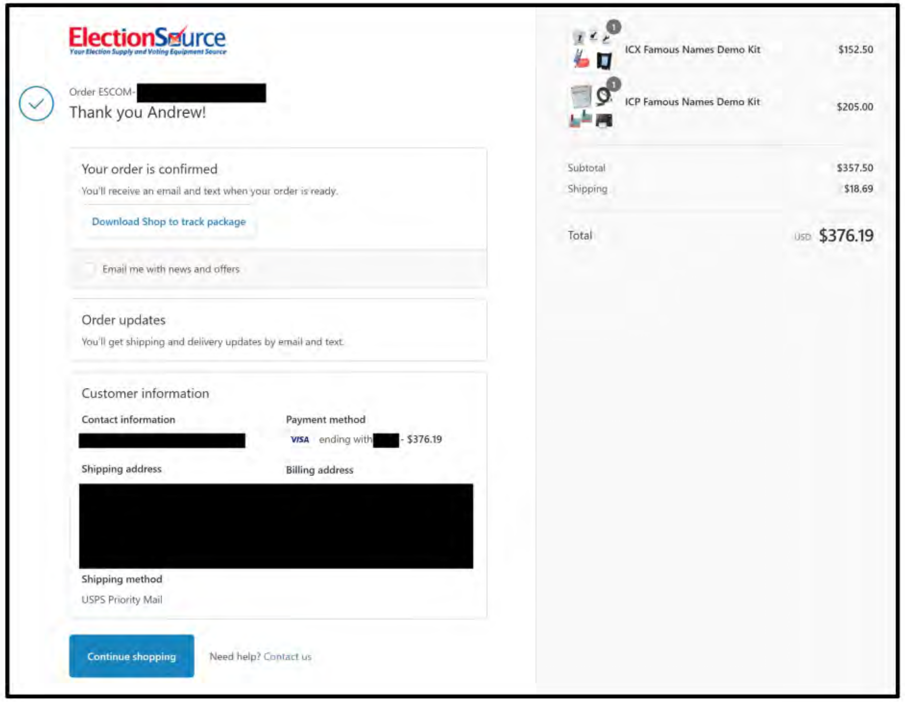


Order ESCOM-[redacted]

Thank you Andrew!

Your order is confirmed

You'll receive an email and text when your order is ready.

Download Shop to track package

□ Email me with news and offers

Order updates

You'll get shipping and delivery updates by email and text.

Customer information

Contact information

[redacted]

Payment method

VISA ending with [redacted] - $376.19

Shipping address

Billing address

[redacted]

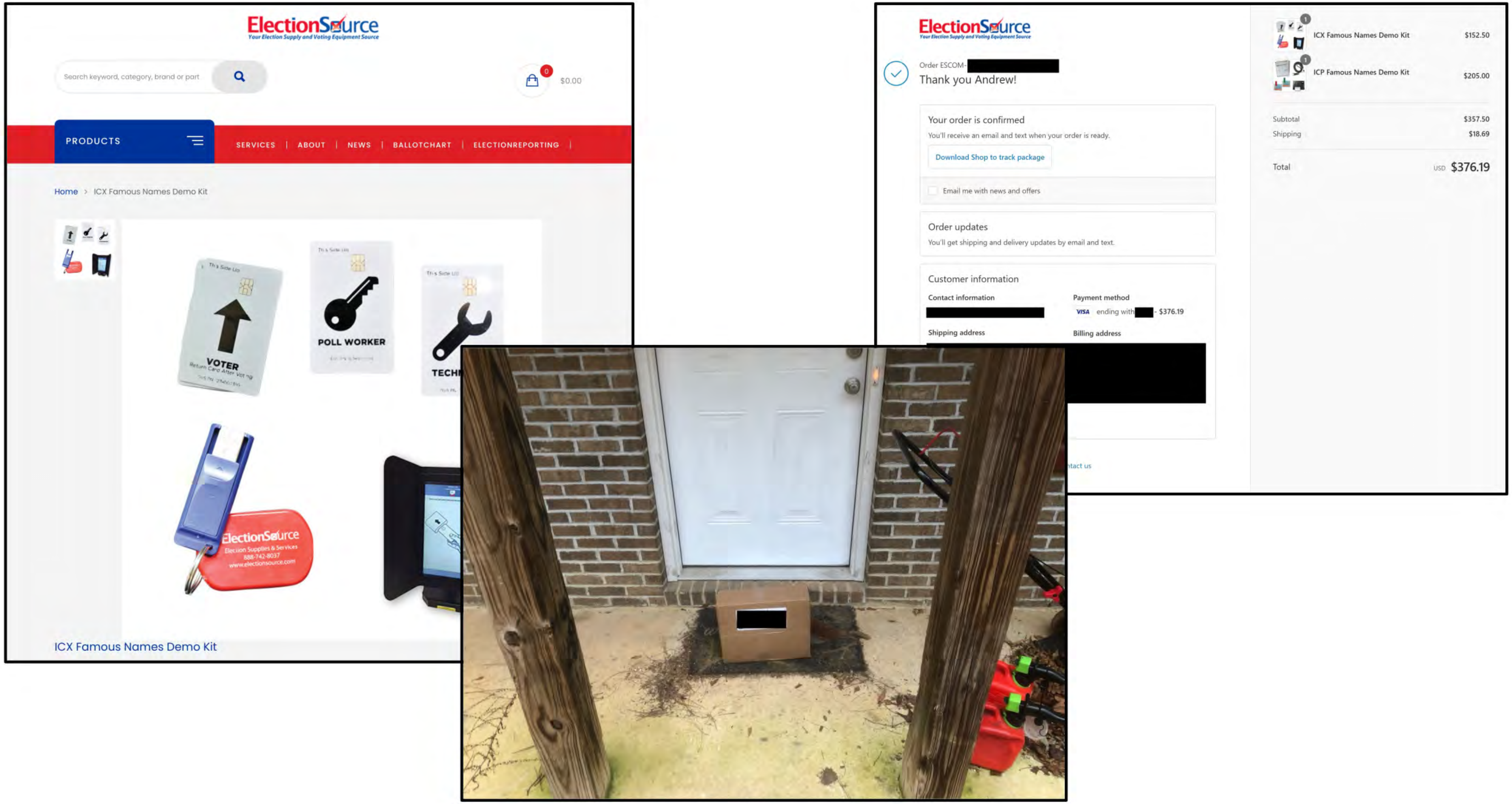
Shipping method

USPS Priority Mail

Need help? Contact us

ICX Famous Names Demo Kit	$152.50
ICP Famous Names Demo Kit	$205.00
Subtotal	$357.50
Shipping	$18.69
Total	USD $376.19

Famous Names Demo Kit Used



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VISA ending with [redacted] - $376.19

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Billing address
[redacted]

ntact us

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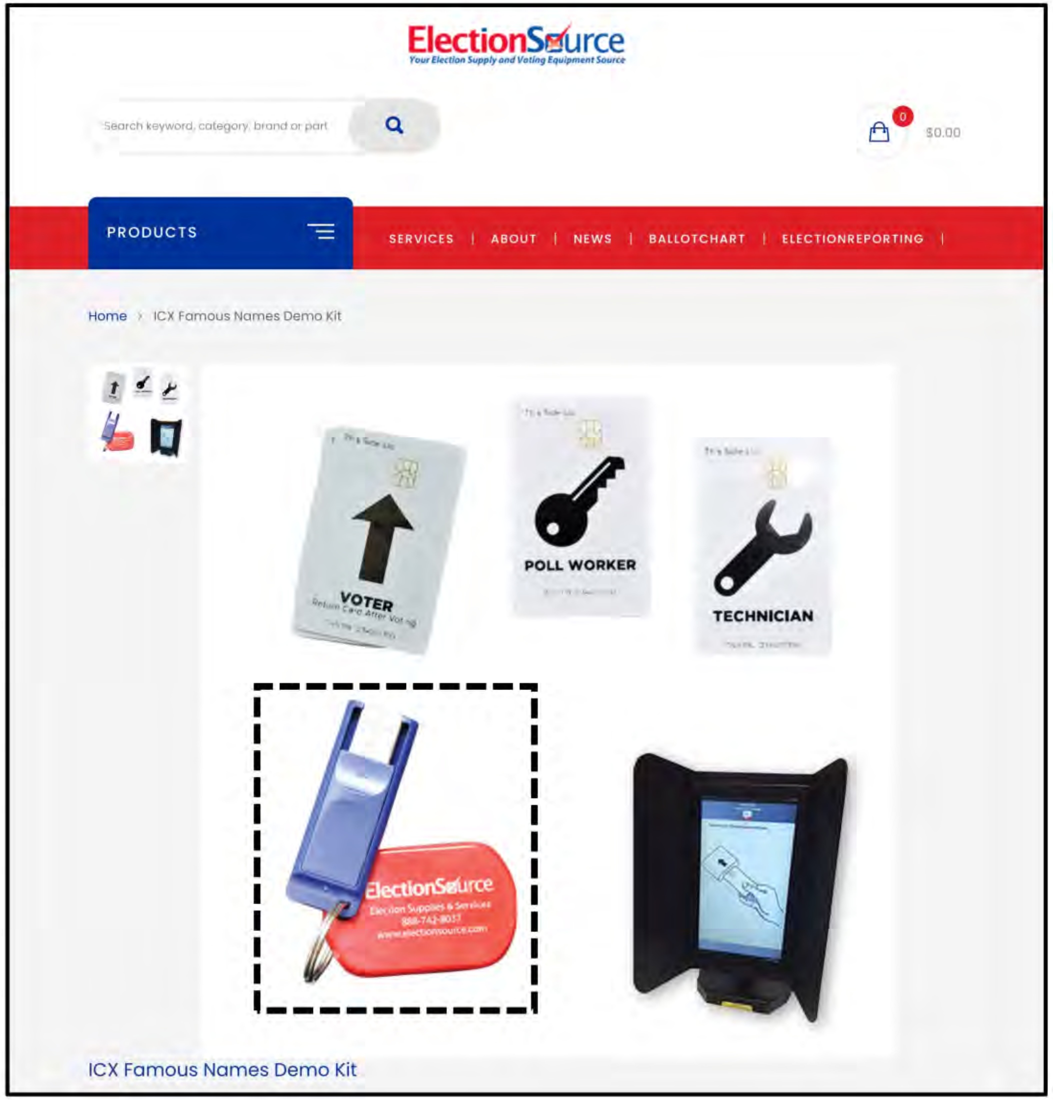

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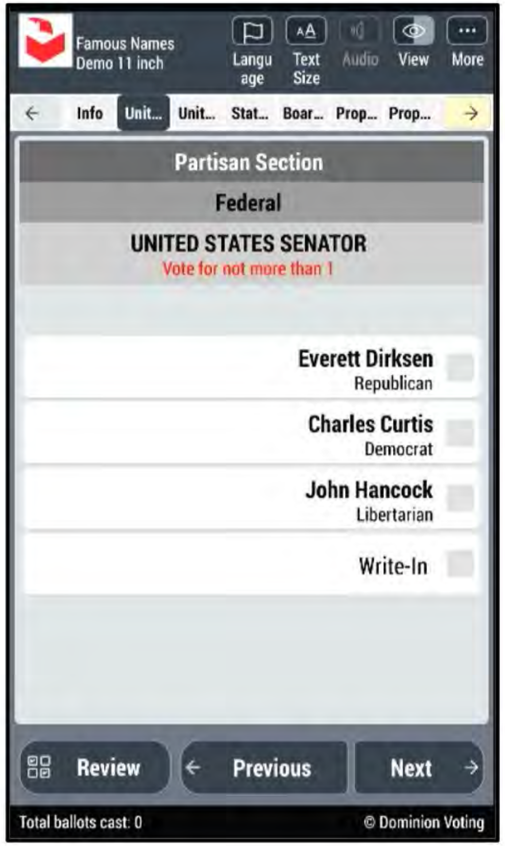
ICX Famous Names Demo Kit

- ICX election definition
  - Made-up election with famous people as candidates



Partisan Section

Federal

UNITED STATES SENATOR

Vote for not more than 1

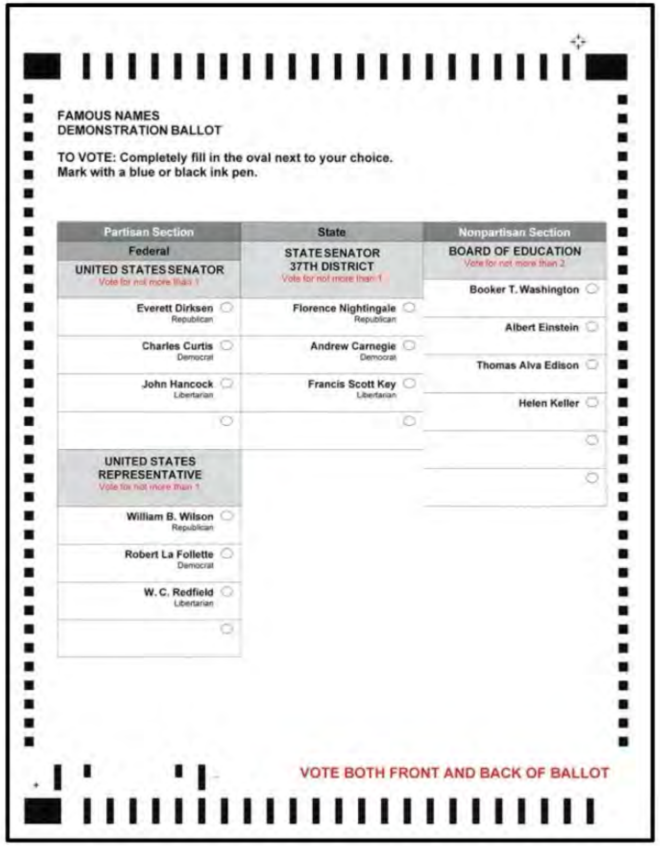
Everett Dirksen
Republican

Charles Curtis
Democrat

John Hancock
Libertarian

Write-In

Total ballots cast: 0



FAMOUS NAMES
DEMONSTRATION BALLOT

TO VOTE: Completely fill in the oval next to your choice.
Mark with a blue or black ink pen.

Partisan Section

Federal

UNITED STATES SENATOR
Vote for not more than 1

Everett Dirksen ○
Republican

Charles Curtis ○
Democrat

John Hancock ○
Libertarian

○

UNITED STATES REPRESENTATIVE
Vote for not more than 1

William B. Wilson ○
Republican

Robert La Follette ○
Democrat

W. C. Redfield ○
Libertarian

○

State

STATE SENATOR
37TH DISTRICT
Vote for not more than 1

Florence Nightingale ○
Republican

Andrew Carnegie ○
Democrat

Francis Scott Key ○
Libertarian

○

Nonpartisan Section

BOARD OF EDUCATION
Vote for not more than 2

Booker T. Washington ○

Albert Einstein ○

Thomas Alva Edison ○

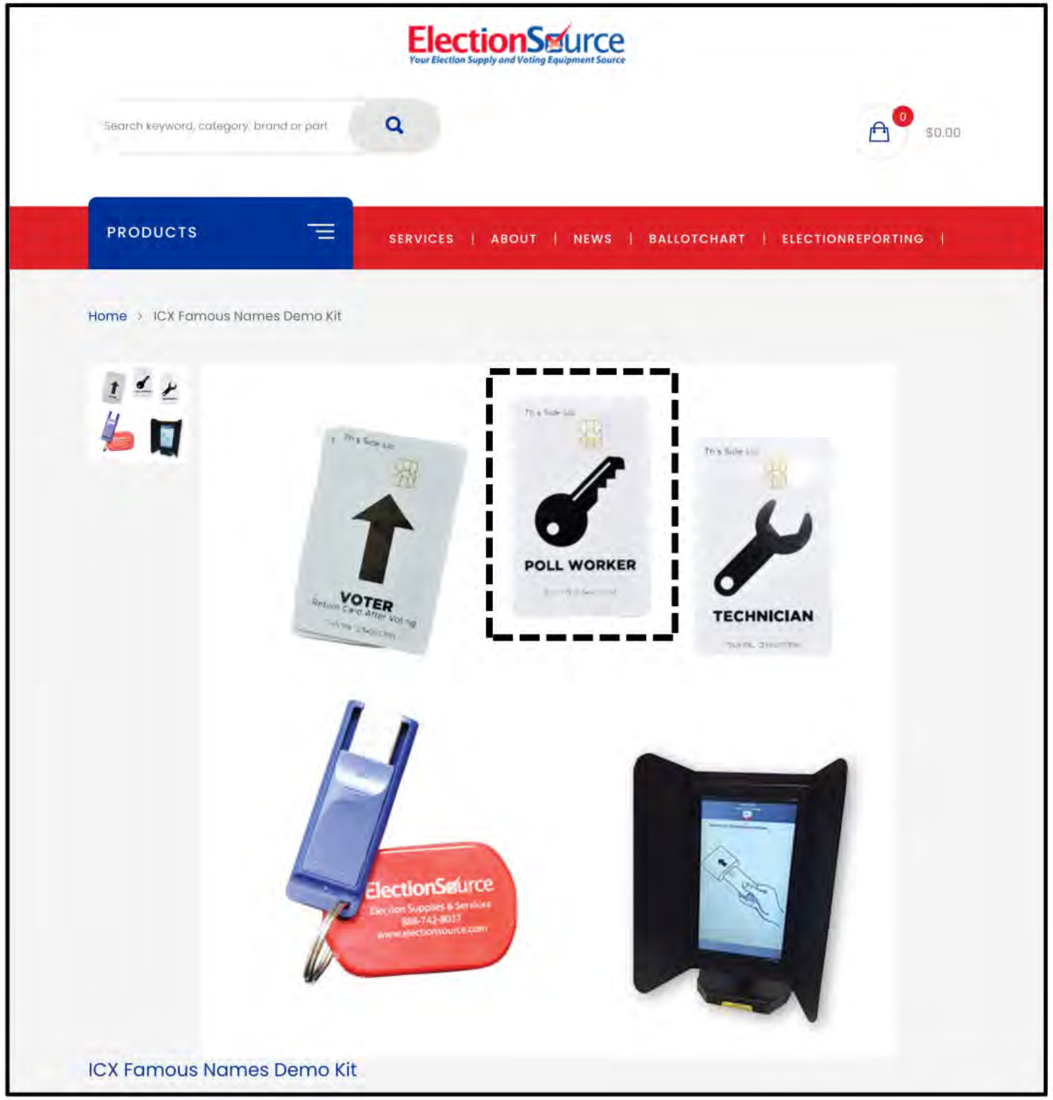
Helen Keller ○

○

○

VOTE BOTH FRONT AND BACK OF BALLOT

Famous Names Demo Kit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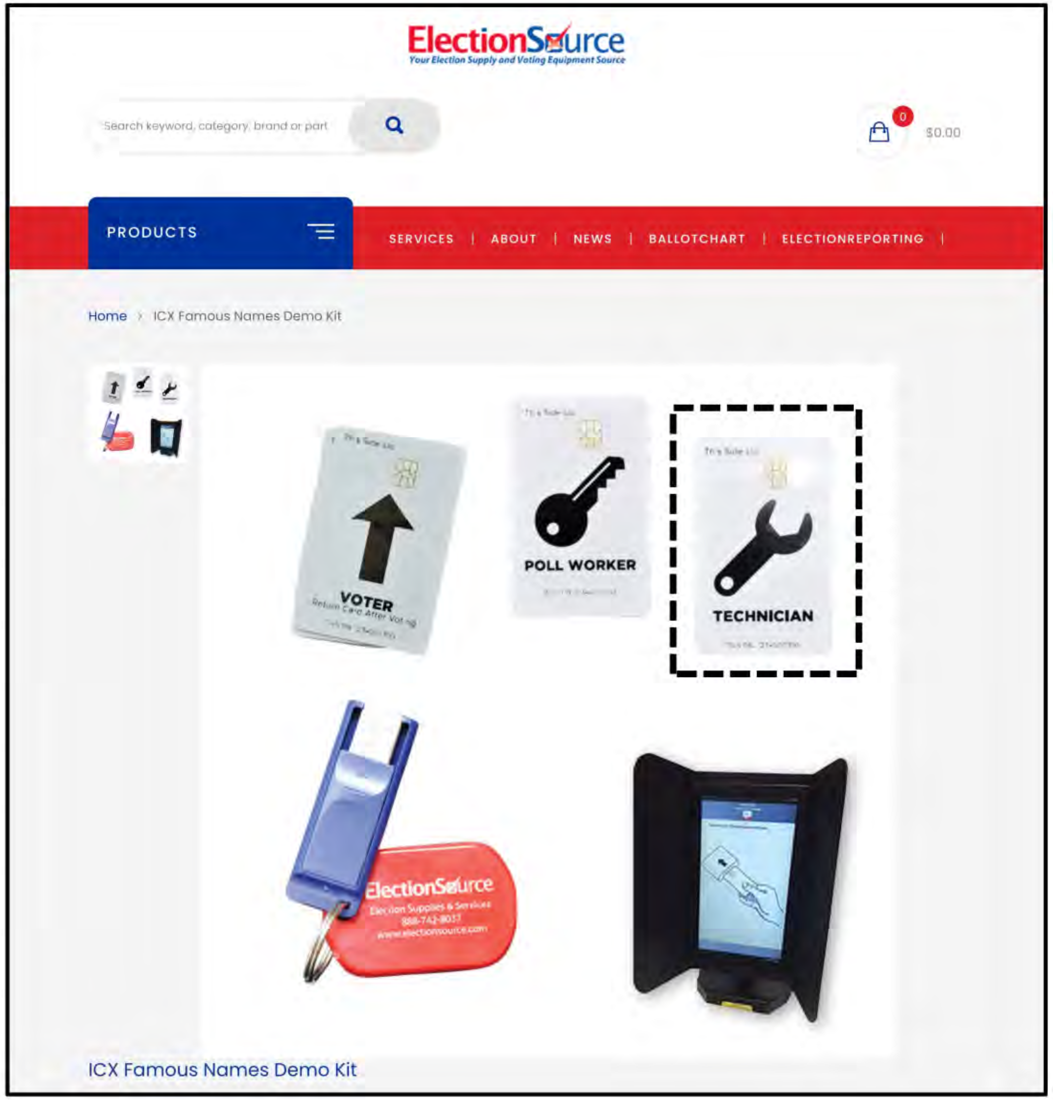
ICX Famous Names Demo Kit

- ICX election definition
- Poll-Worker Card
  - PIN provided with kit
  - Specific to demo-election

Famous Names Demo Kit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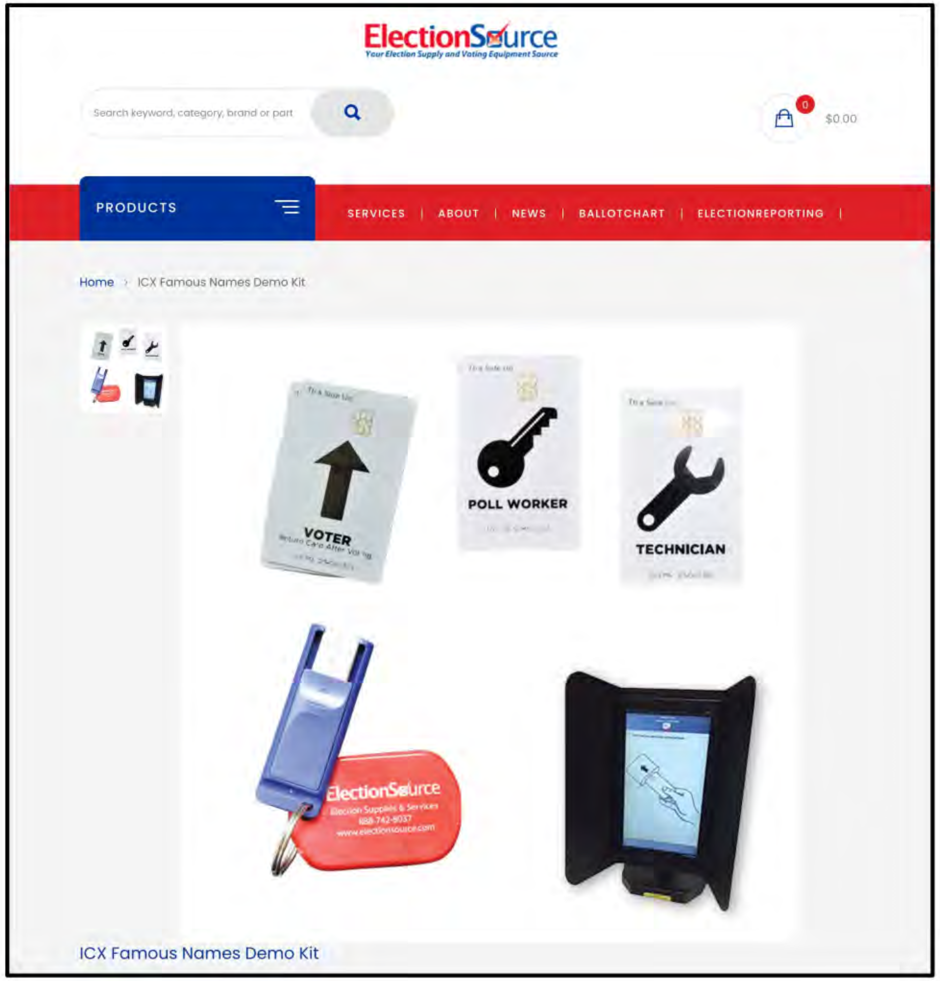
ICX Famous Names Demo Kit

- ICX election definition
- Poll-Worker Card
- Technician Card
  - PIN provided with kit
  - **NOT specific to demo-election**

Famous Names Demo Kit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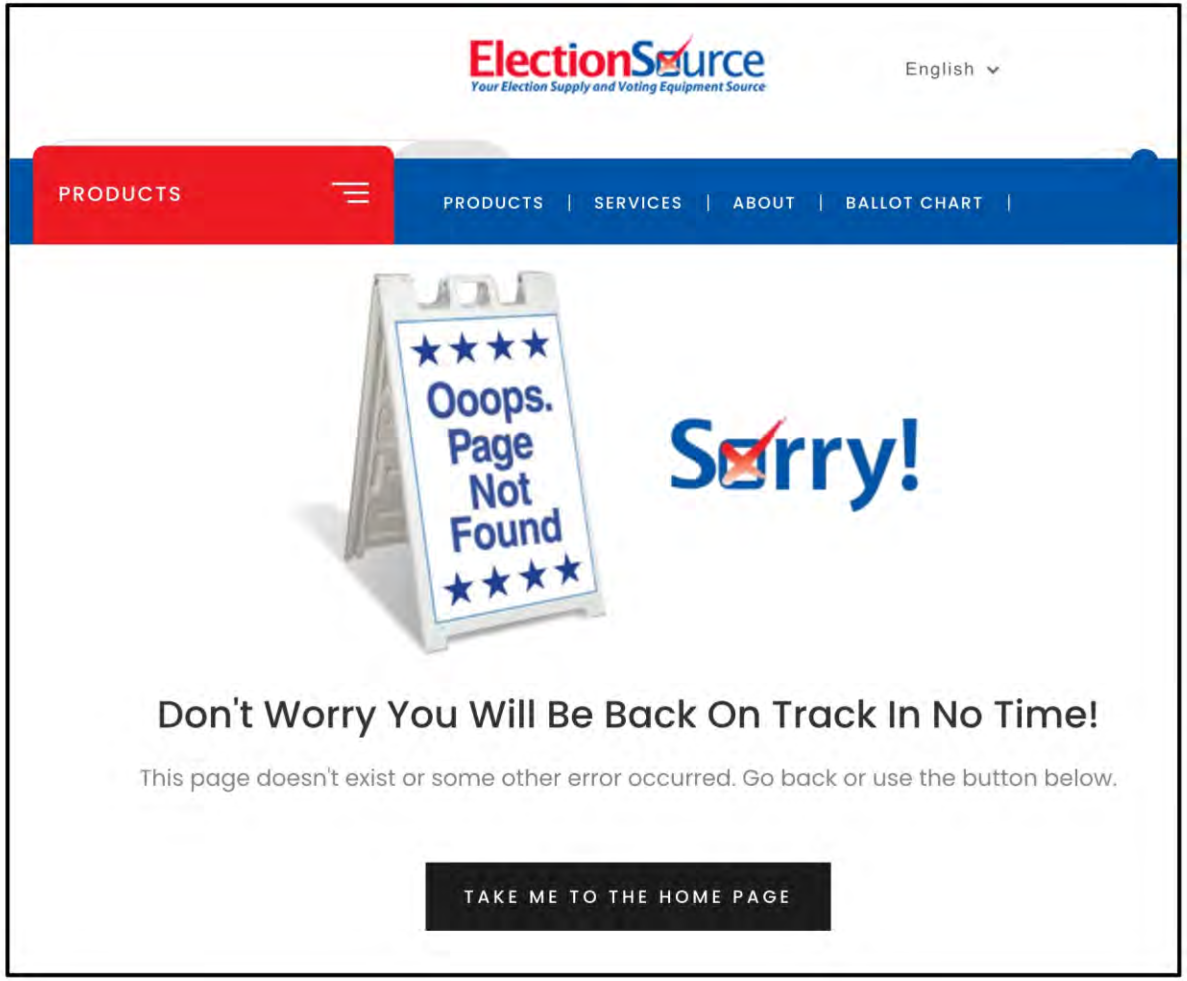
ICX Famous Names Demo Kit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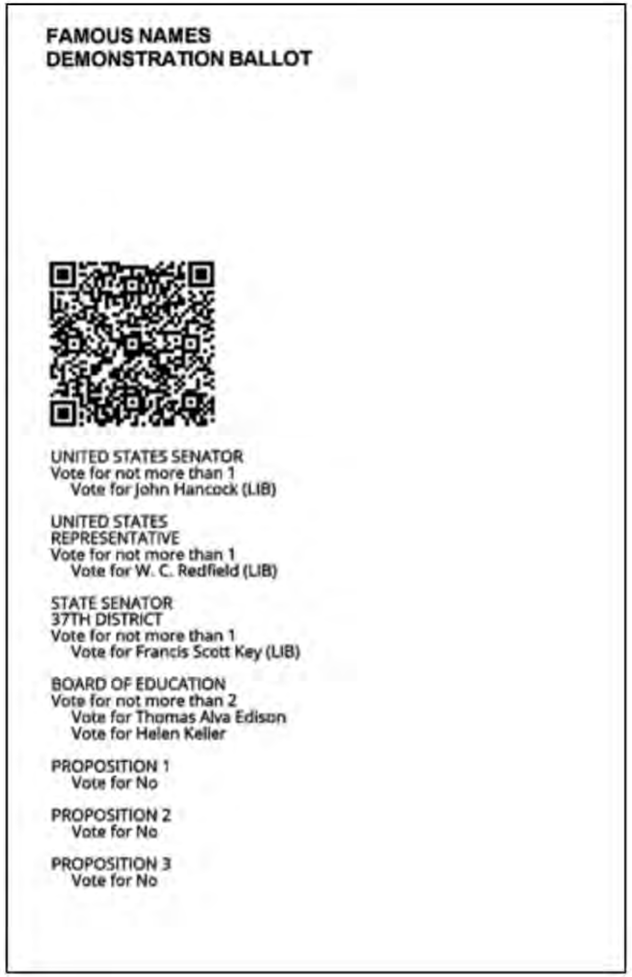
QR-Code Ballots

- Printed by ICX via COTS printer



FAMOUS NAMES
DEMONSTRATION BALLOT

UNITED STATES SENATOR
Vote for not more than 1
Vote for John Hancock (LIB)

UNITED STATES
REPRESENTATIVE
Vote for not more than 1
Vote for W. C. Redfield (LIB)

STATE SENATOR
37TH DISTRICT
Vote for not more than 1
Vote for Francis Scott Key (LIB)

BOARD OF EDUCATION
Vote for not more than 2
Vote for Thomas Alva Edison
Vote for Helen Keller

PROPOSITION 1
Vote for No

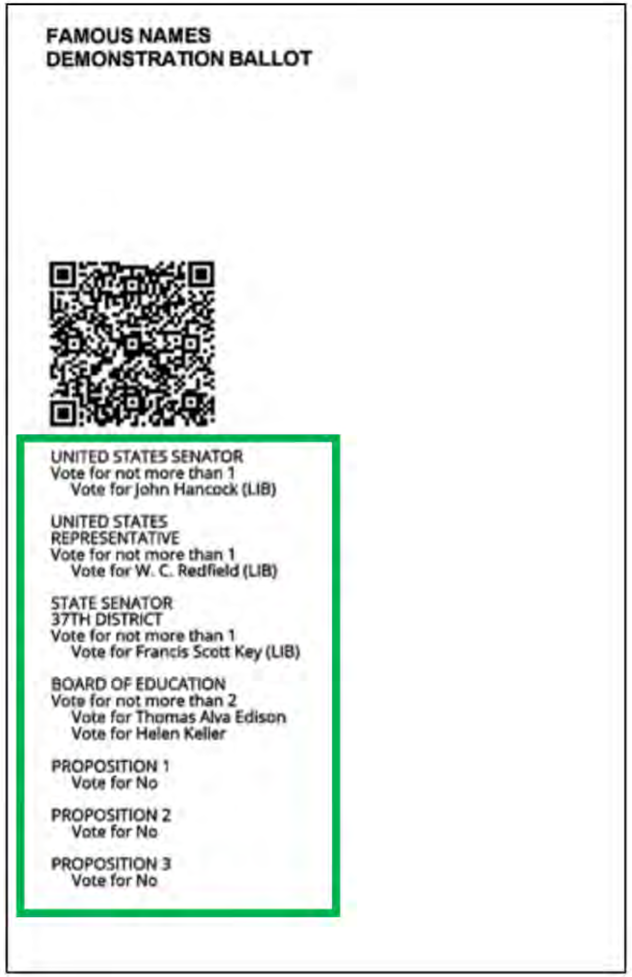
PROPOSITION 2
Vote for No

PROPOSITION 3
Vote for No

QR-Code Ballots

- Printed by ICX via COTS printer

- Summary text (human readable)
  - Used for *some* types of audits



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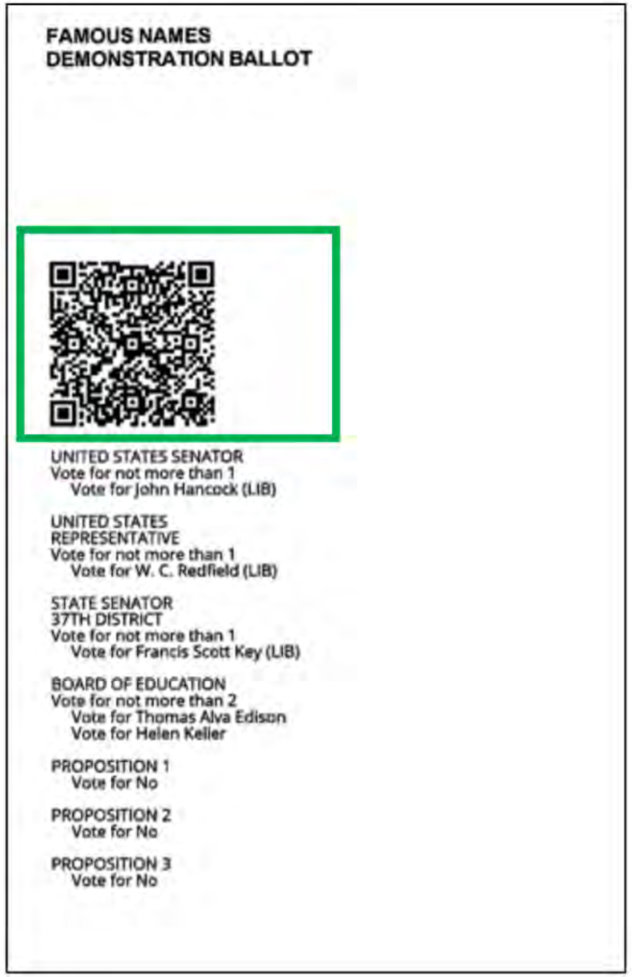
Vote for No

QR-Code Ballots

- Printed by ICX via COTS printer

- Summary text (human readable)
  - Used for *some* types of audits

- QR-Code (machine readable)
  - Interpreted by the scanner to recover voter’s selections



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Vote for No

PROPOSITION 3
Vote for No

QR-Code Ballots

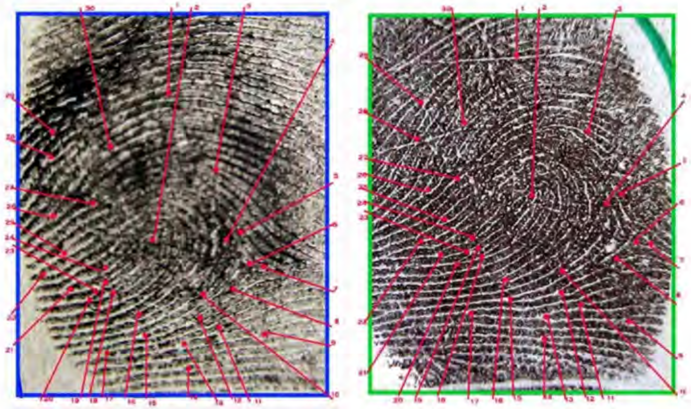
- Printed by ICX via COTS printer
- Summary text (human readable)
  - Used for *some* types of audits
- QR-Code (machine readable)
  - Interpreted by the scanner to recover voter's selections
  - The **only** part of ballot that is read by scanner
  - Contents/Interpretation details are publicly-available*

[redacted]

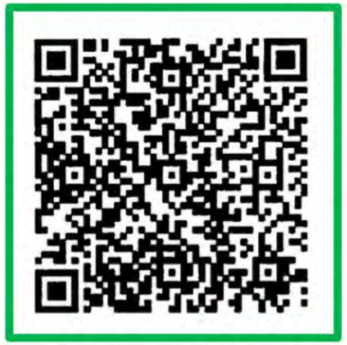
* Security Analysis of Georgia's ImageCast X Ballot Marking Device (2021)

QR-Code Comparison

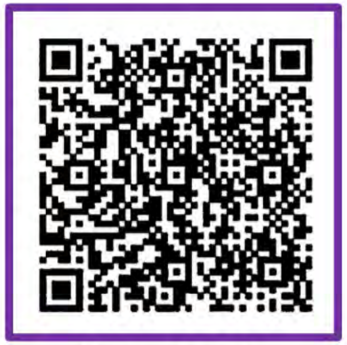
Fingerprint Comparison



QR-Code Comparison



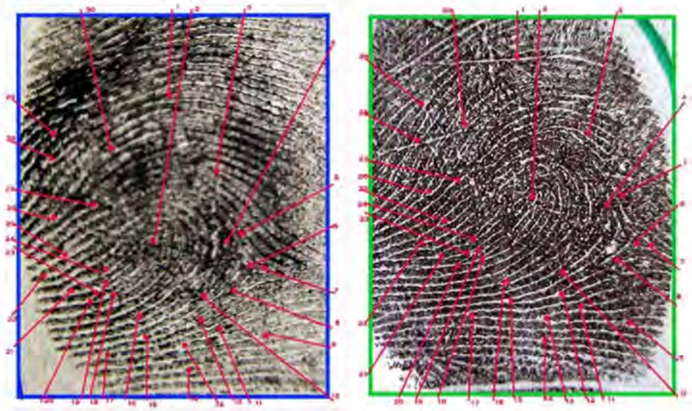
Unmodified



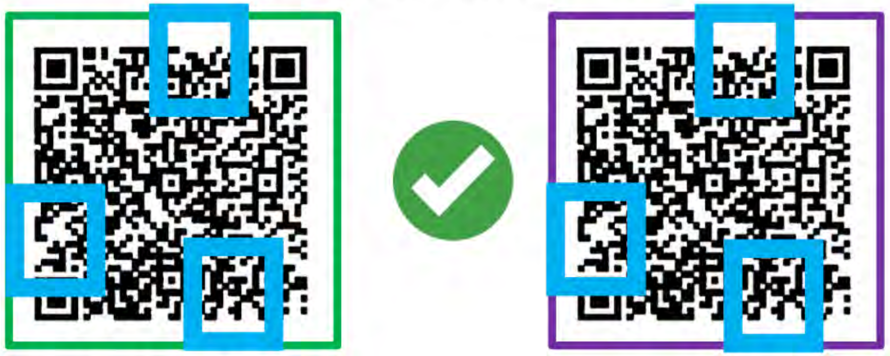
Created

QR-Code Comparison

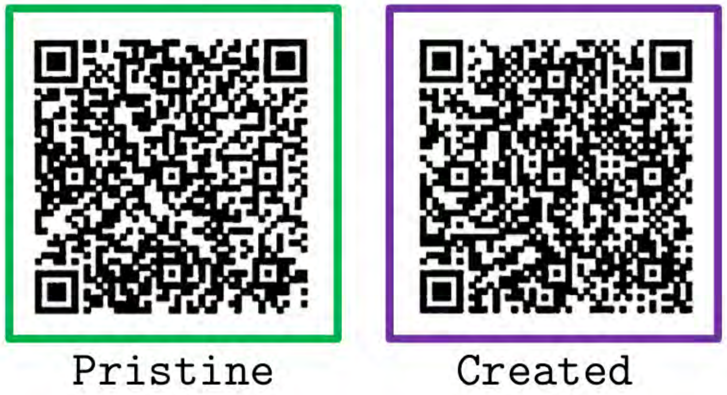
Fingerprint Comparison



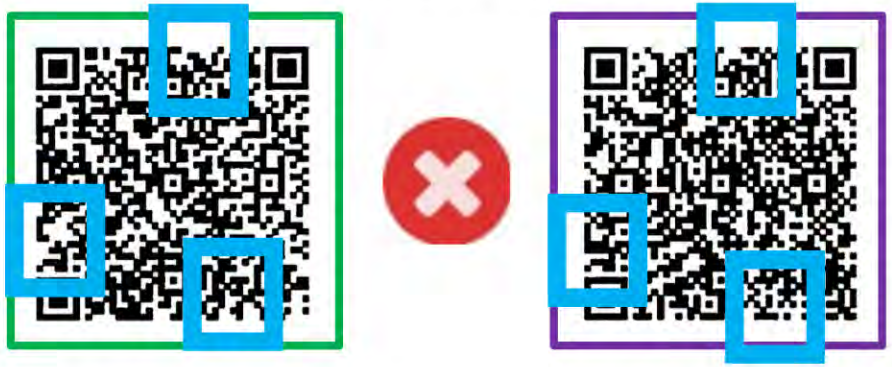
Matching Comparison



QR-Code Comparison

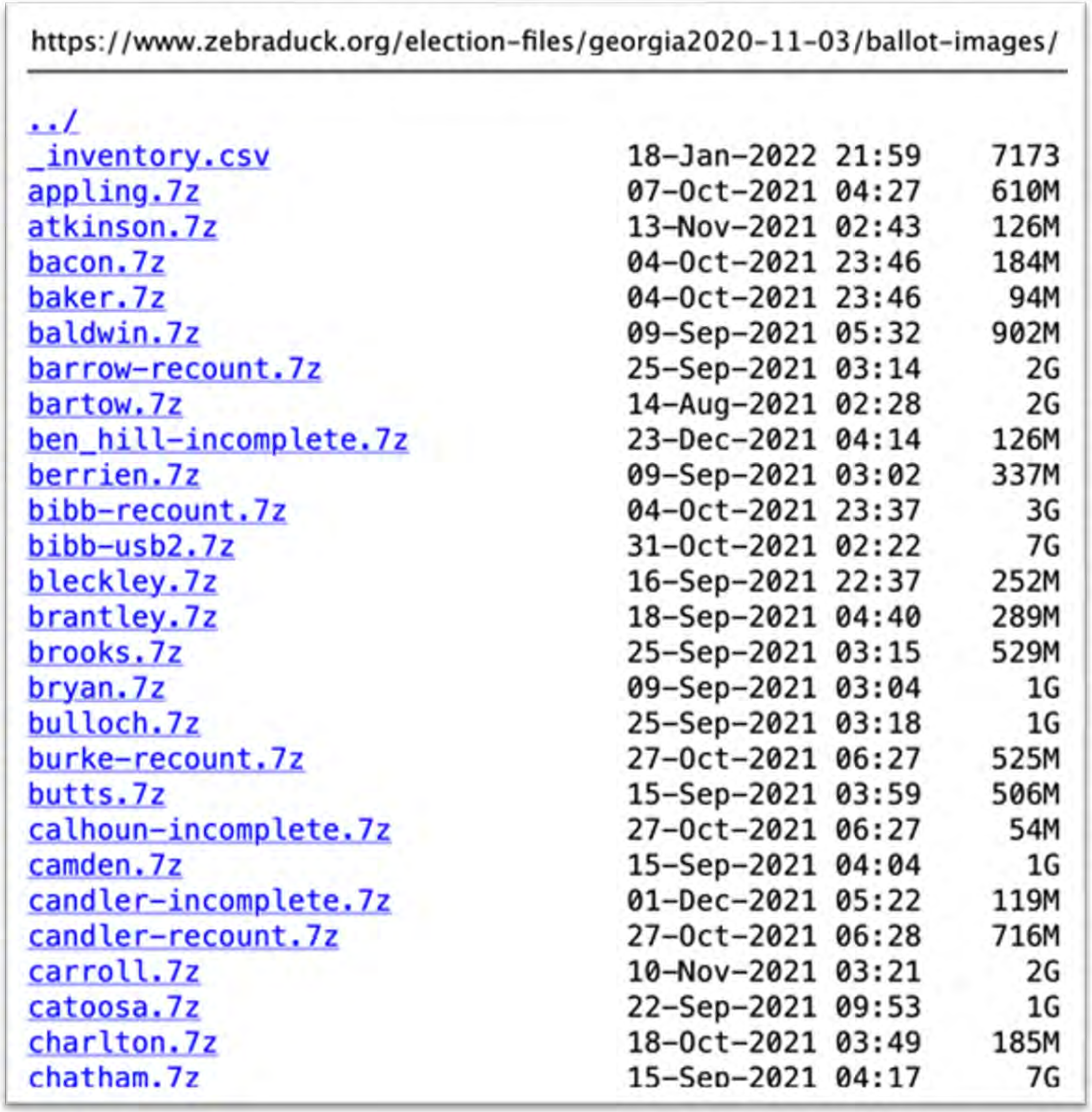


Non-Matching Comparison



ZebraDuck public online election data

Five Georgia counties had released their restricted election databases and were found on an online site of public election data.



https://www.zebraduck.org/election-files/georgia2020-11-03/ballot-images/

```
../
_inventory.csv                  18-Jan-2022 21:59    7173
appling.7z                      07-Oct-2021 04:27    610M
atkinson.7z                     13-Nov-2021 02:43    126M
bacon.7z                        04-Oct-2021 23:46    184M
baker.7z                        04-Oct-2021 23:46     94M
baldwin.7z                      09-Sep-2021 05:32    902M
barrow-recount.7z               25-Sep-2021 03:14      2G
bartow.7z                       14-Aug-2021 02:28      2G
ben_hill-incomplete.7z          23-Dec-2021 04:14    126M
berrien.7z                      09-Sep-2021 03:02    337M
bibb-recount.7z                 04-Oct-2021 23:37      3G
bibb-usb2.7z                    31-Oct-2021 02:22      7G
bleckley.7z                     16-Sep-2021 22:37    252M
brantley.7z                     18-Sep-2021 04:40    289M
brooks.7z                       25-Sep-2021 03:15    529M
bryan.7z                        09-Sep-2021 03:04      1G
bulloch.7z                      25-Sep-2021 03:18      1G
burke-recount.7z                27-Oct-2021 06:27    525M
butts.7z                        15-Sep-2021 03:59    506M
calhoun-incomplete.7z           27-Oct-2021 06:27     54M
camden.7z                       15-Sep-2021 04:04      1G
candler-incomplete.7z           01-Dec-2021 05:22    119M
candler-recount.7z              27-Oct-2021 06:28    716M
carroll.7z                      10-Nov-2021 03:21      2G
catoosa.7z                      22-Sep-2021 09:53      1G
charlton.7z                     18-Oct-2021 03:49    185M
chatham.7z                      15-Sep-2021 04:17      7G
```

Restricted Election Databases Released

These were databases that contained ballot, contest and candidate election data.

Restricted Election Databases Released

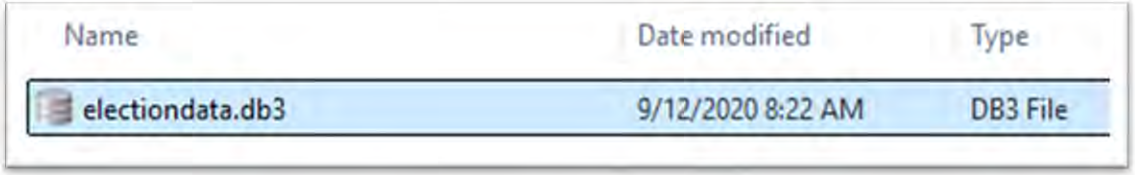
These were databases that contained ballot, contest and candidate election data.

Contained in one of the table was the county's encryption keys and HMAC key.

- **Name**
  Appling Nov 2020 General
- **AES Key**
  H^n19wW$lK~02&yX
- **AES Vector**
  6Kv%Dc&1|A2k7rE$
- **HMAC Key**
  0x396424503F454262527E6C34304E5B741133694775593
  62632675E514A7C376F

County ICX Touch Screen Configuration Files

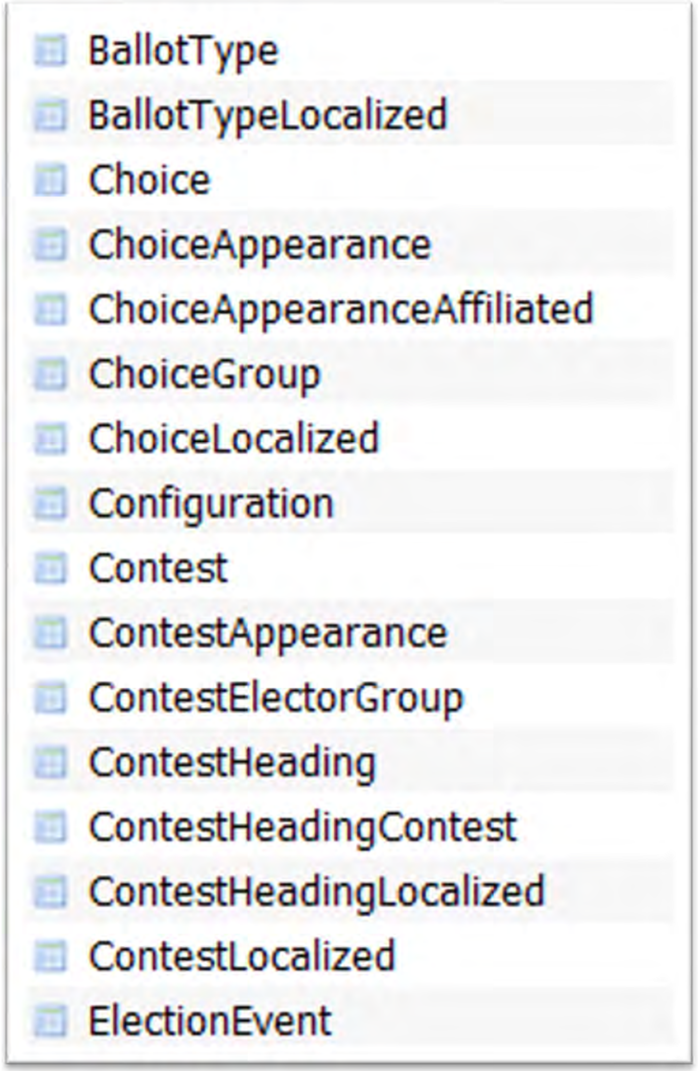
After finding the configuration file for the ICX, I was able to decrypt and decompress the data file using the encryption keys and locate a SQLite database.



Name	Date modified	Type
electiondata.db3	9/12/2020 8:22 AM	DB3 File

ICX SQLite Database

The ICX's database was a very basic design that contains the ballot styles, choices and contests.

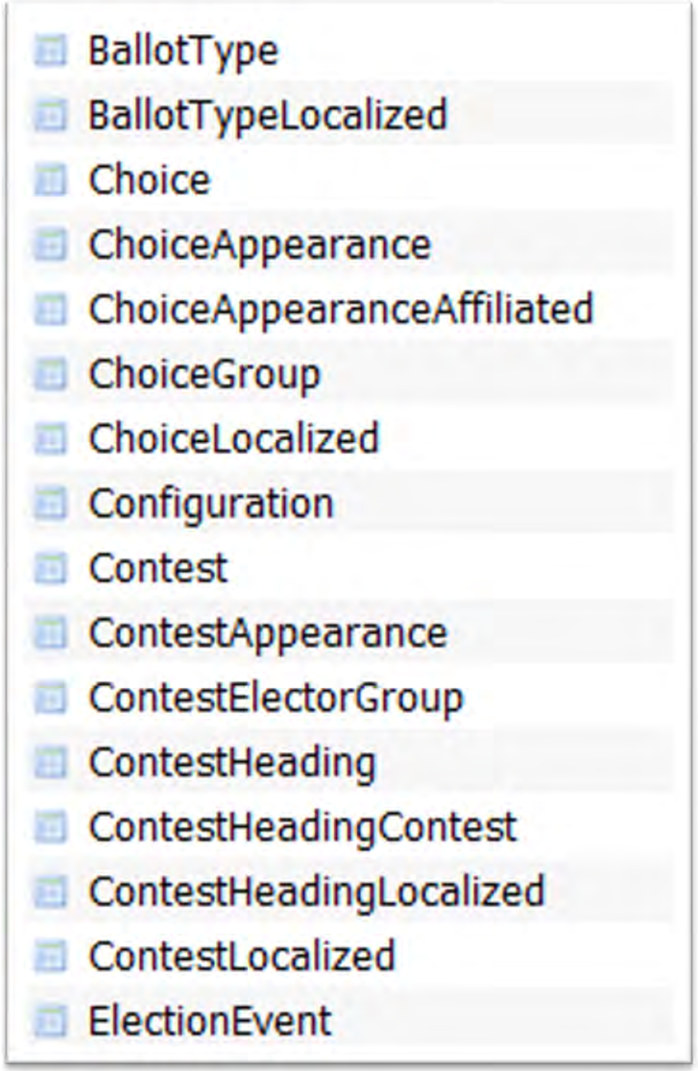


BallotType
BallotTypeLocalized
Choice
ChoiceAppearance
ChoiceAppearanceAffiliated
ChoiceGroup
ChoiceLocalized
Configuration
Contest
ContestAppearance
ContestElectorGroup
ContestHeading
ContestHeadingContest
ContestHeadingLocalized
ContestLocalized
ElectionEvent

ICX SQLite Database

The ICX's database was a very basic design that contains the ballot styles, choices and contests.

The voting software uses these tables to present a user interface to the voter. By changing these values, we can change what the voter sees.



BallotType
BallotTypeLocalized
Choice
ChoiceAppearance
ChoiceAppearanceAffiliated
ChoiceGroup
ChoiceLocalized
Configuration
Contest
ContestAppearance
ContestElectorGroup
ContestHeading
ContestHeadingContest
ContestHeadingLocalized
ContestLocalized
ElectionEvent

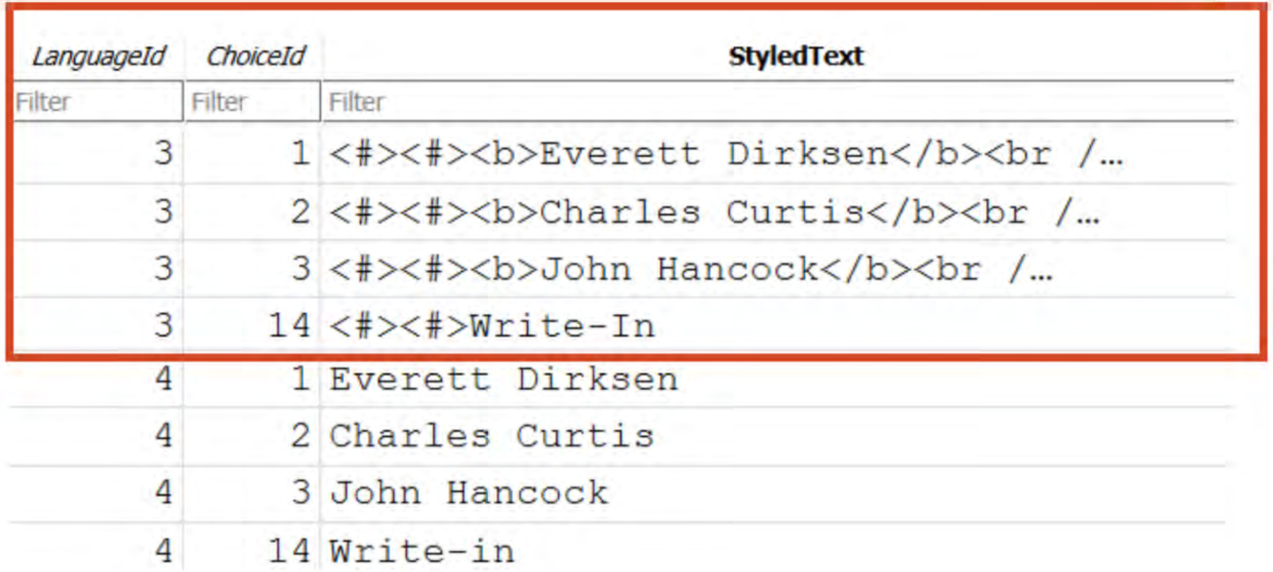
Localized Data Tables

The resources used in the voting application

Choice Localized

This table is designed to allow for multi-lingual support. It holds the localization values of the choices in the current election

Display resources are written in HTML and is used to generate how the candidate or the ballot question is presented on the screen



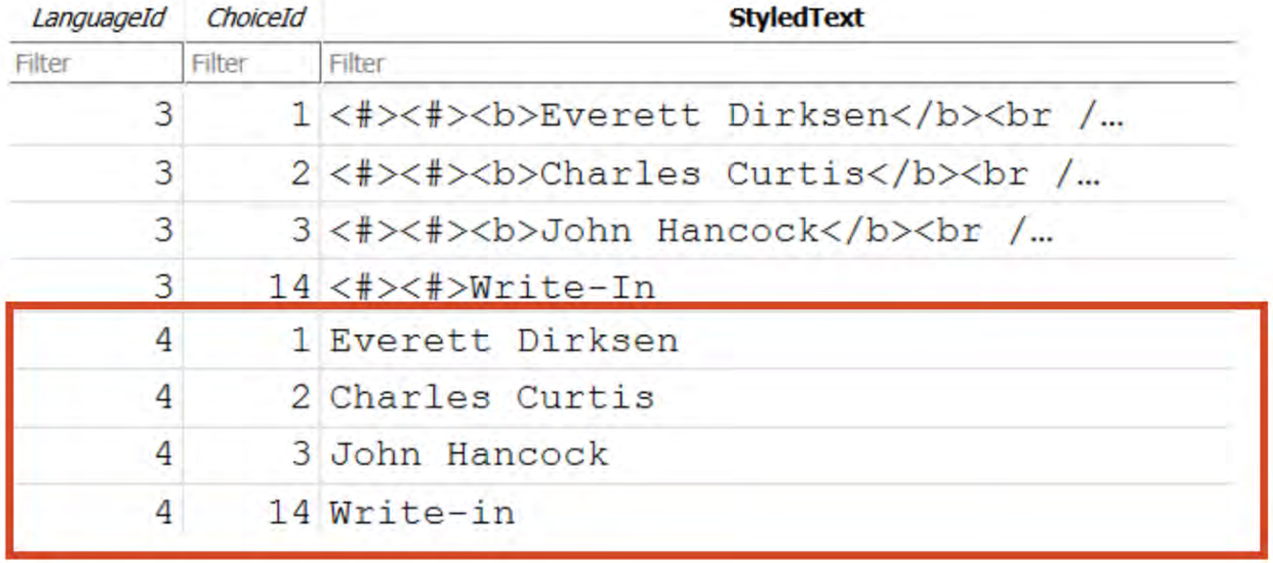
LanguageId	ChoiceId	StyledText
Filter	Filter	Filter
3	1	<#><#><b>Everett Dirksen</b><br /...
3	2	<#><#><b>Charles Curtis</b><br /...
3	3	<#><#><b>John Hancock</b><br /...
3	14	<#><#>Write-In
4	1	Everett Dirksen
4	2	Charles Curtis
4	3	John Hancock
4	14	Write-in

Choice Localized

This table is designed to allow for multi-lingual support. It holds the localization values of the choices in the current election

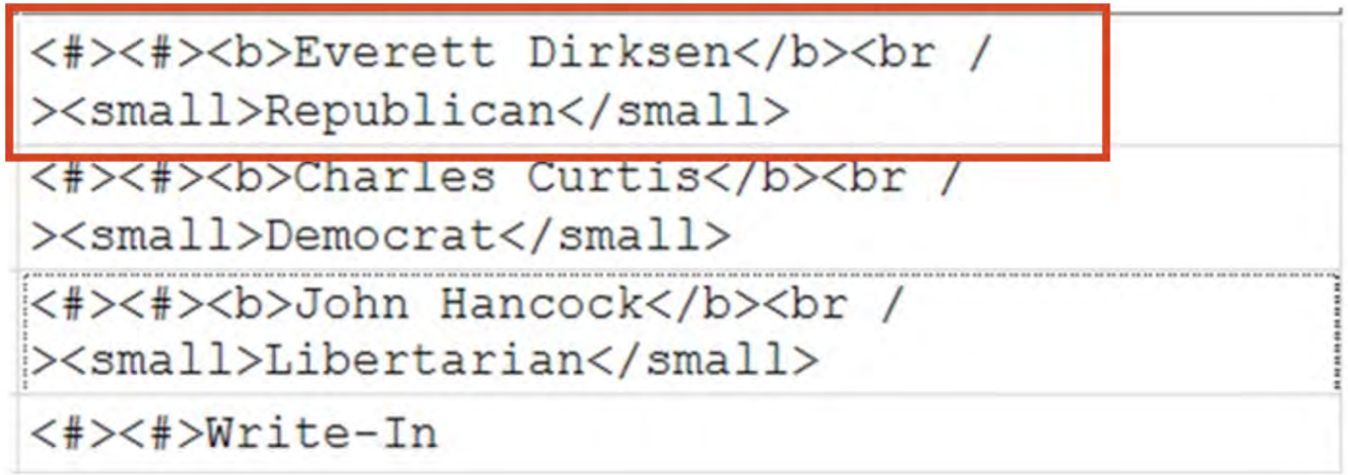
Display resources are written in HTML and is used to generate how the candidate or the ballot question is presented on the screen

Printer resources are plain text and is used to print the candidates name on the voted ballot.

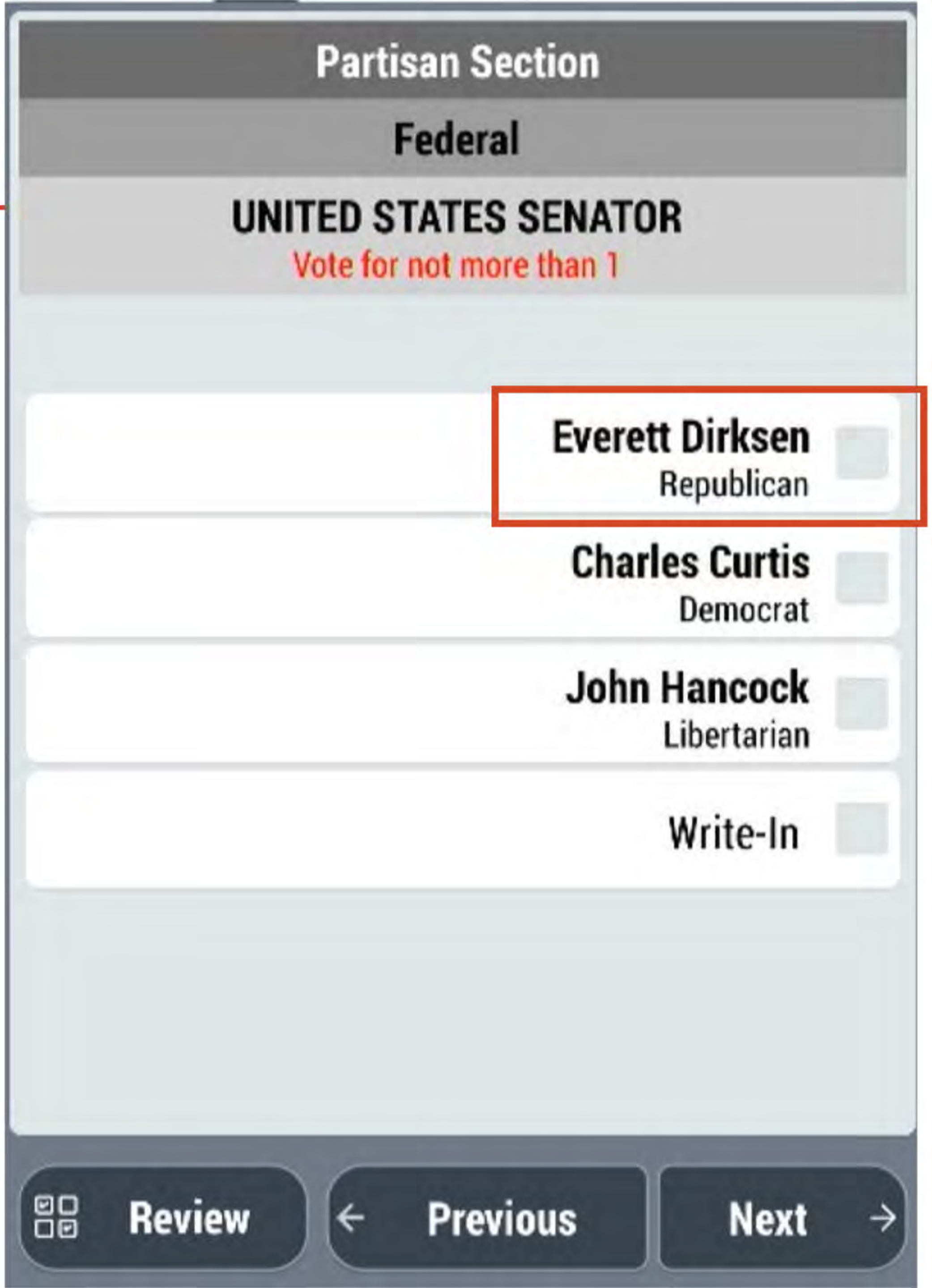


LanguageId	ChoiceId	StyledText
Filter	Filter	Filter
3	1	<#><#><b>Everett Dirksen</b><br /…
3	2	<#><#><b>Charles Curtis</b><br /…
3	3	<#><#><b>John Hancock</b><br /…
3	14	<#><#>Write-In
4	1	Everett Dirksen
4	2	Charles Curtis
4	3	John Hancock
4	14	Write-in

Choice Localized – Display Resources



```
<#><#><b>Everett Dirksen</b><br />
<small>Republican</small>
<#><#><b>Charles Curtis</b><br />
<small>Democrat</small>
<#><#><b>John Hancock</b><br />
<small>Libertarian</small>
<#><#>Write-In
```



Partisan Section

Federal

UNITED STATES SENATOR

Vote for not more than 1

Everett Dirksen
Republican □

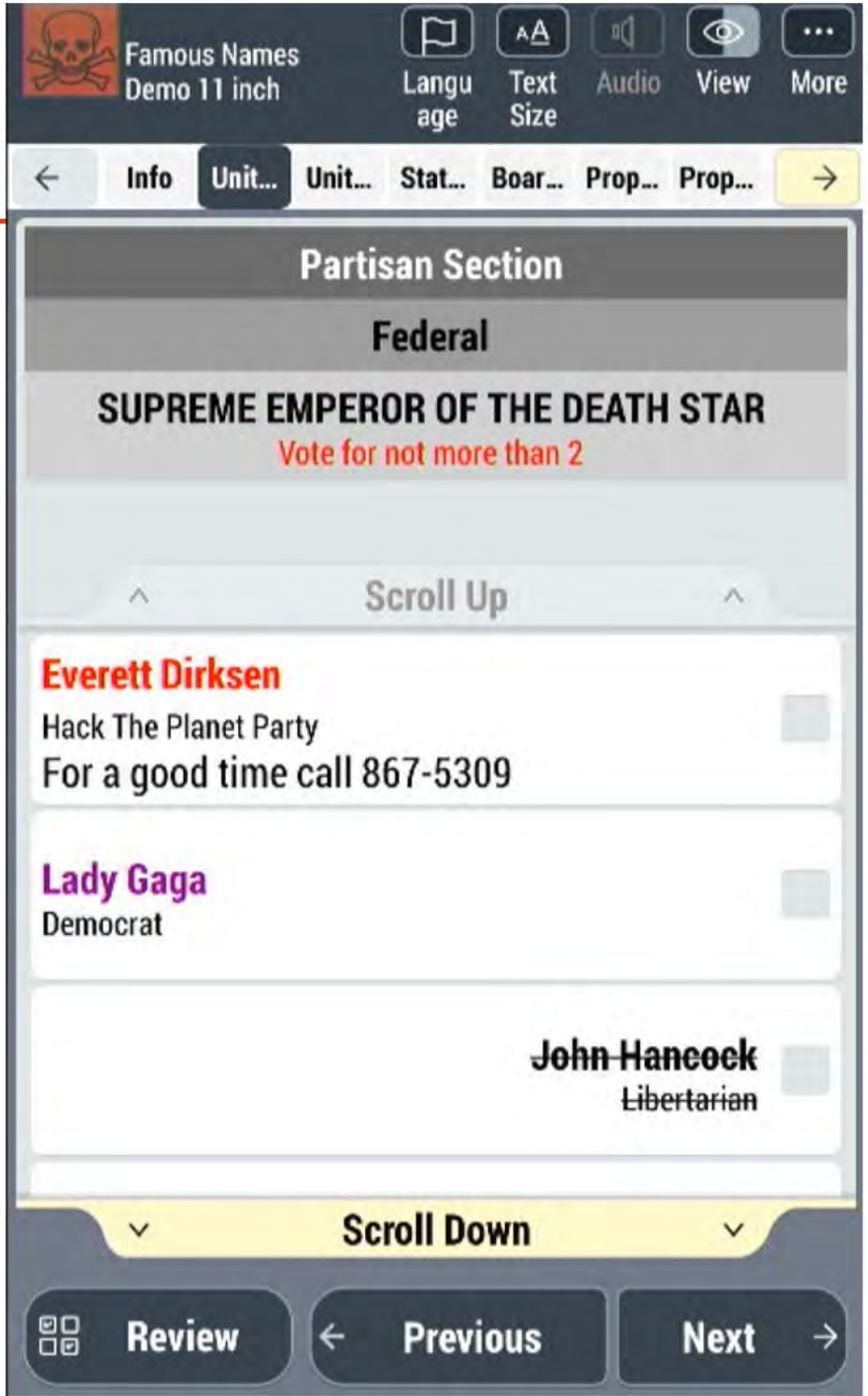
Charles Curtis
Democrat □

John Hancock
Libertarian □

Write-In □

Complete control of the display

Almost full control of the ICX display is achieved if the database file is modified.



Partisan Section

Federal

SUPREME EMPEROR OF THE DEATH STAR

Vote for not more than 2

Everett Dirksen

Hack The Planet Party

For a good time call 867-5309

□

Lady Gaga

Democrat

□

~~John Hancock~~

~~Libertarian~~

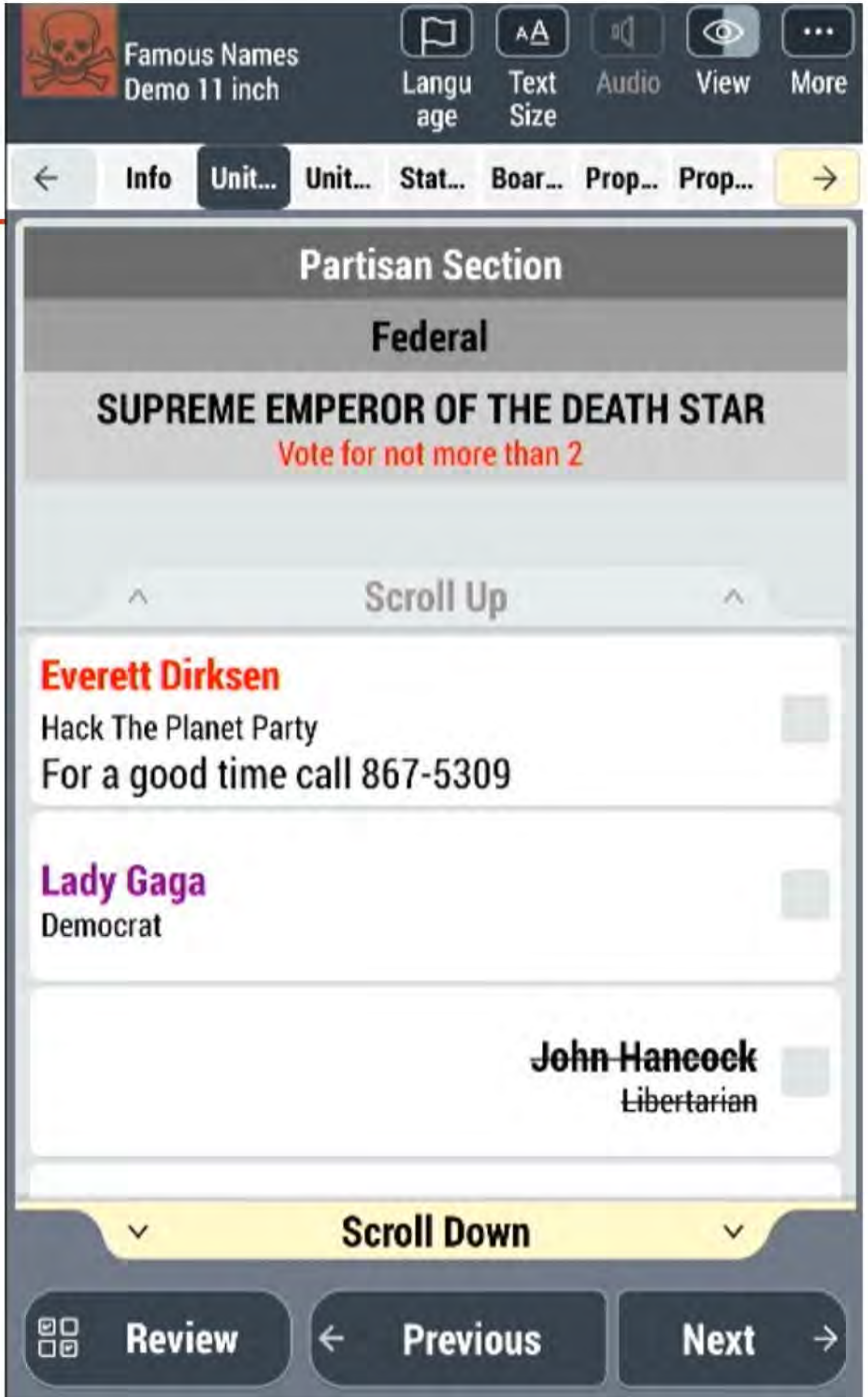
□

Complete control of the display

Almost full control of the ICX display is achieved if the database file is modified.

An attacker can change nearly every aspect of the display.

- Displayed text
- Printed ballot text
- Number of choices per race
- Party affiliations
- Disabling of contests/candidates
- Candidate order



Famous Names Demo 11 inch

Partisan Section

Federal

SUPREME EMPEROR OF THE DEATH STAR

Vote for not more than 2

Everett Dirksen

Hack The Planet Party

For a good time call 867-5309

Lady Gaga

Democrat

~~John Hancock~~

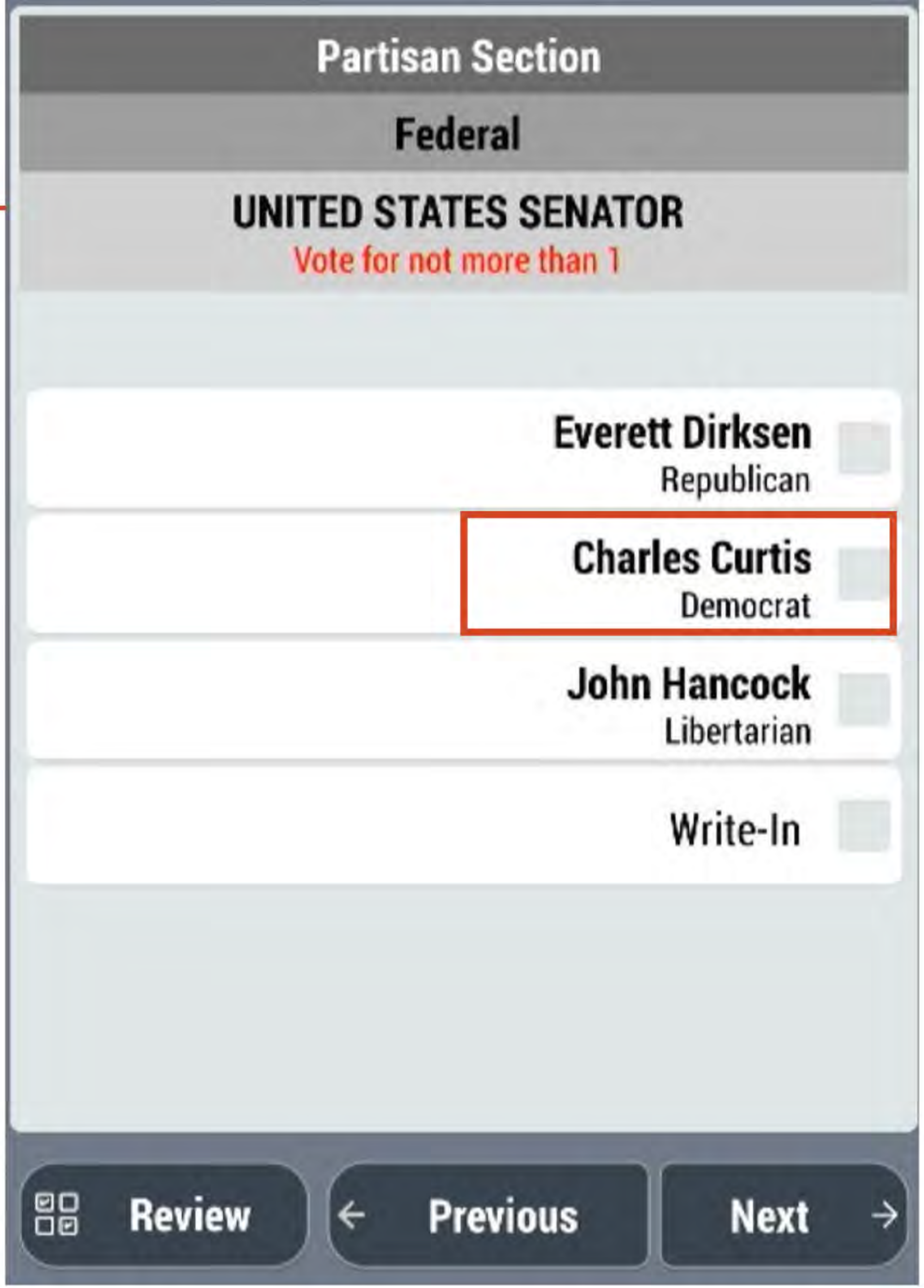
~~Libertarian~~

Hacking the Voter

Creating hacks by influencing the voter’s intent

Hacking the Voter

Altering the candidate's party affiliation may influence a voter's decision.



Partisan Section

Federal

UNITED STATES SENATOR

Vote for not more than 1

Everett Dirksen
Republican □

Charles Curtis
Democrat □

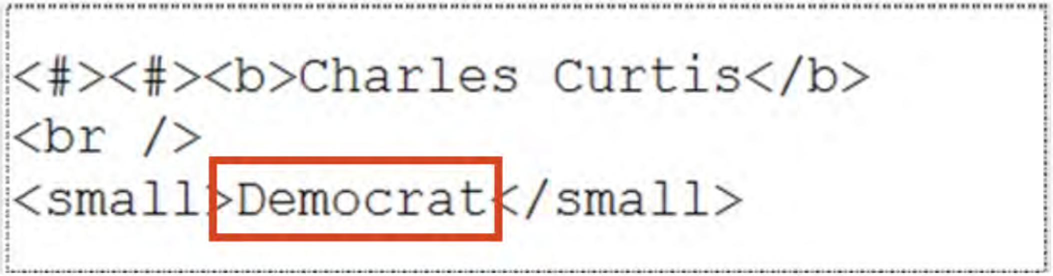
John Hancock
Libertarian □

Write-In □

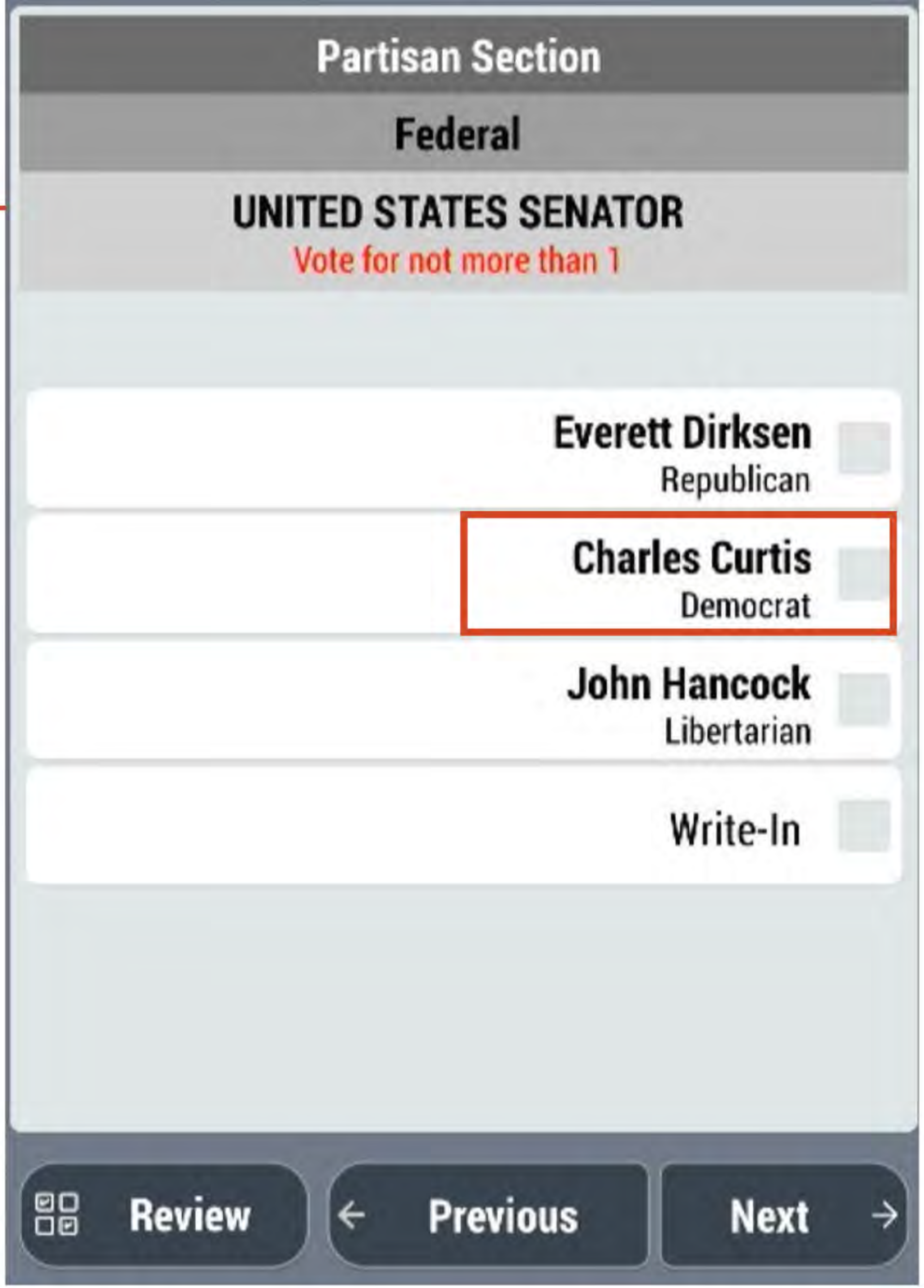
Hacking the Voter

Altering the candidate’s party affiliation may influence a voter’s decision.

Changing the HTML value for this candidate, from



```
<#><#><b>Charles Curtis</b>
<br />
<small>Democrat</small>
```



Partisan Section

Federal

UNITED STATES SENATOR

Vote for not more than 1

Everett Dirksen
Republican □

Charles Curtis
Democrat □

John Hancock
Libertarian □

Write-In □

Hacking the Voter

Altering the candidate’s party affiliation may influence a voter’s decision.

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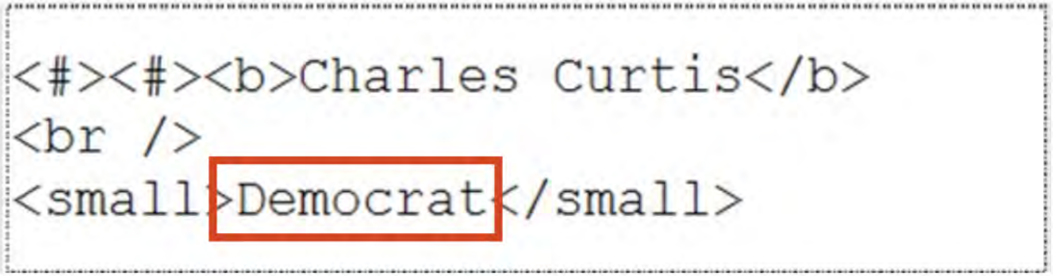
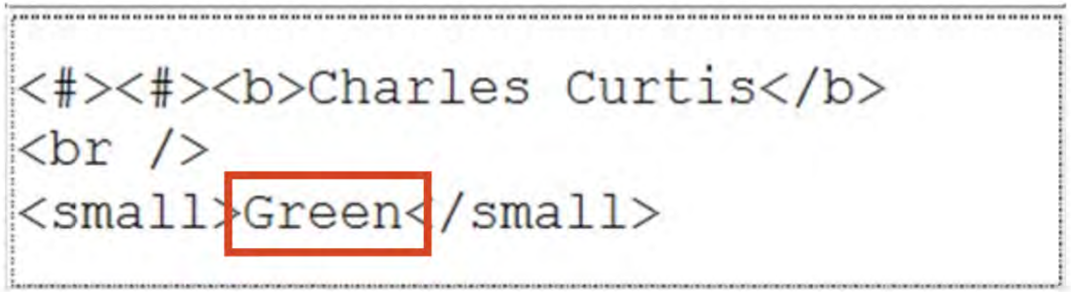
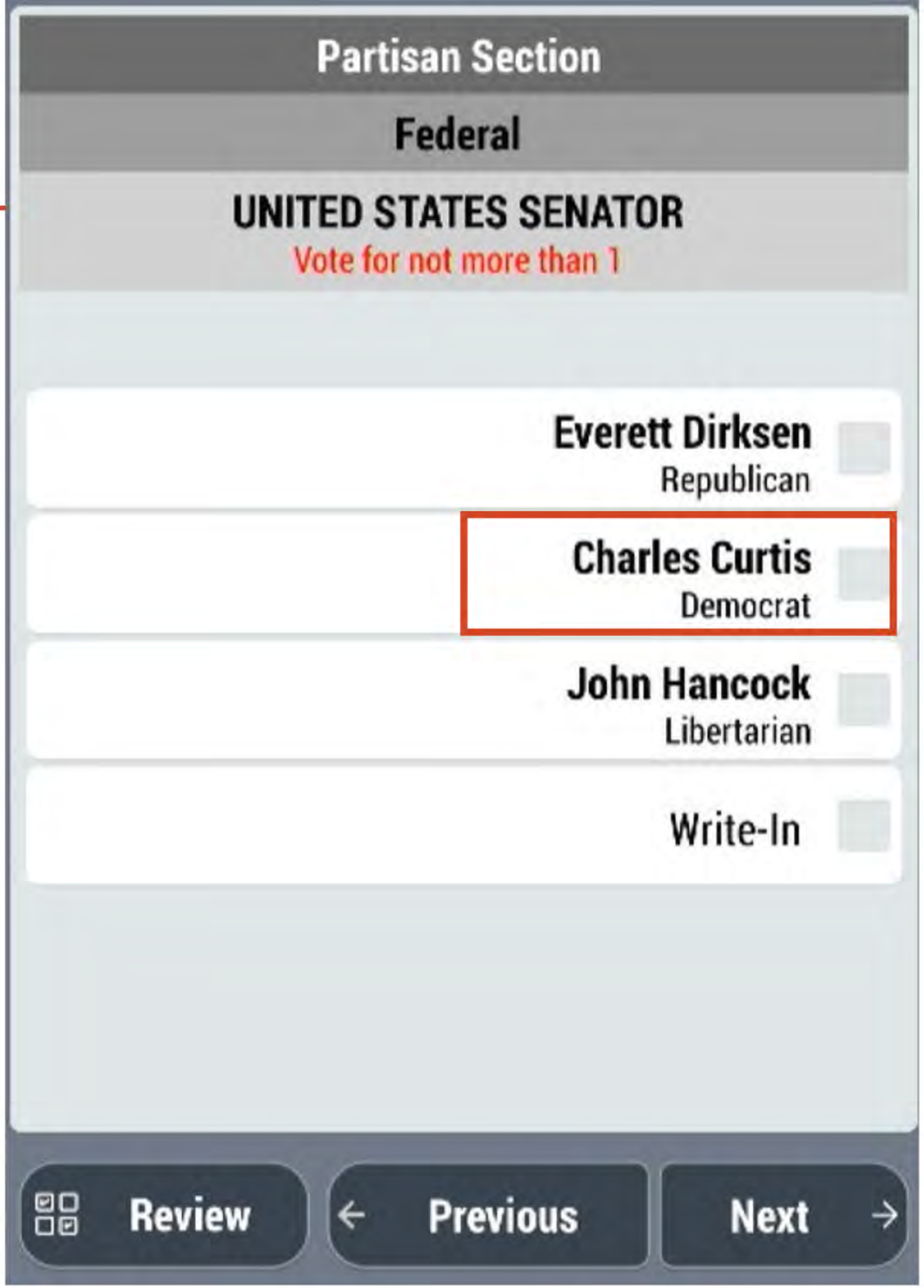


```
<#><#><b>Charles Curtis</b>
<br />
<small>Democrat</small>
```

To a different party.



```
<#><#><b>Charles Curtis</b>
<br />
<small>Green</small>
```



Partisan Section

Federal

UNITED STATES SENATOR

Vote for not more than 1

Everett Dirksen
Republican □

Charles Curtis
Democrat □

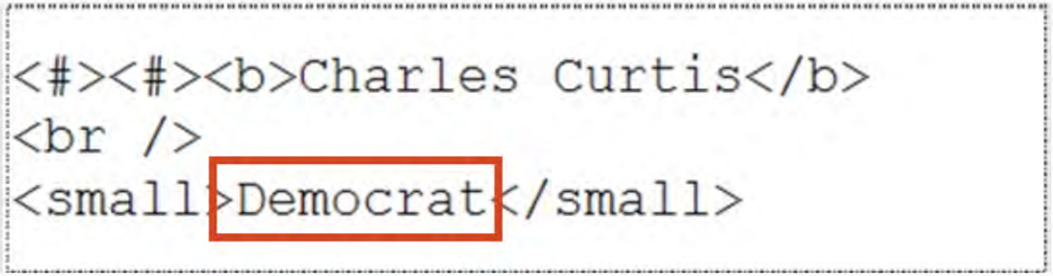
John Hancock
Libertarian □

Write-In □

Hacking the Voter

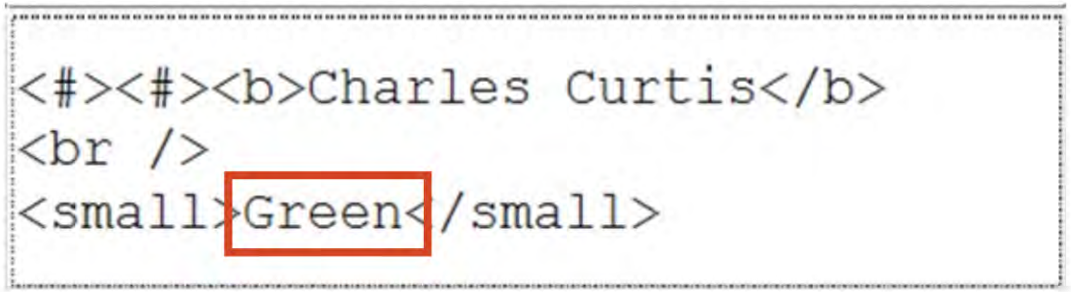
Altering the candidate's party affiliation may influence a voter's decision.

Changing the HTML value for this candidate, from

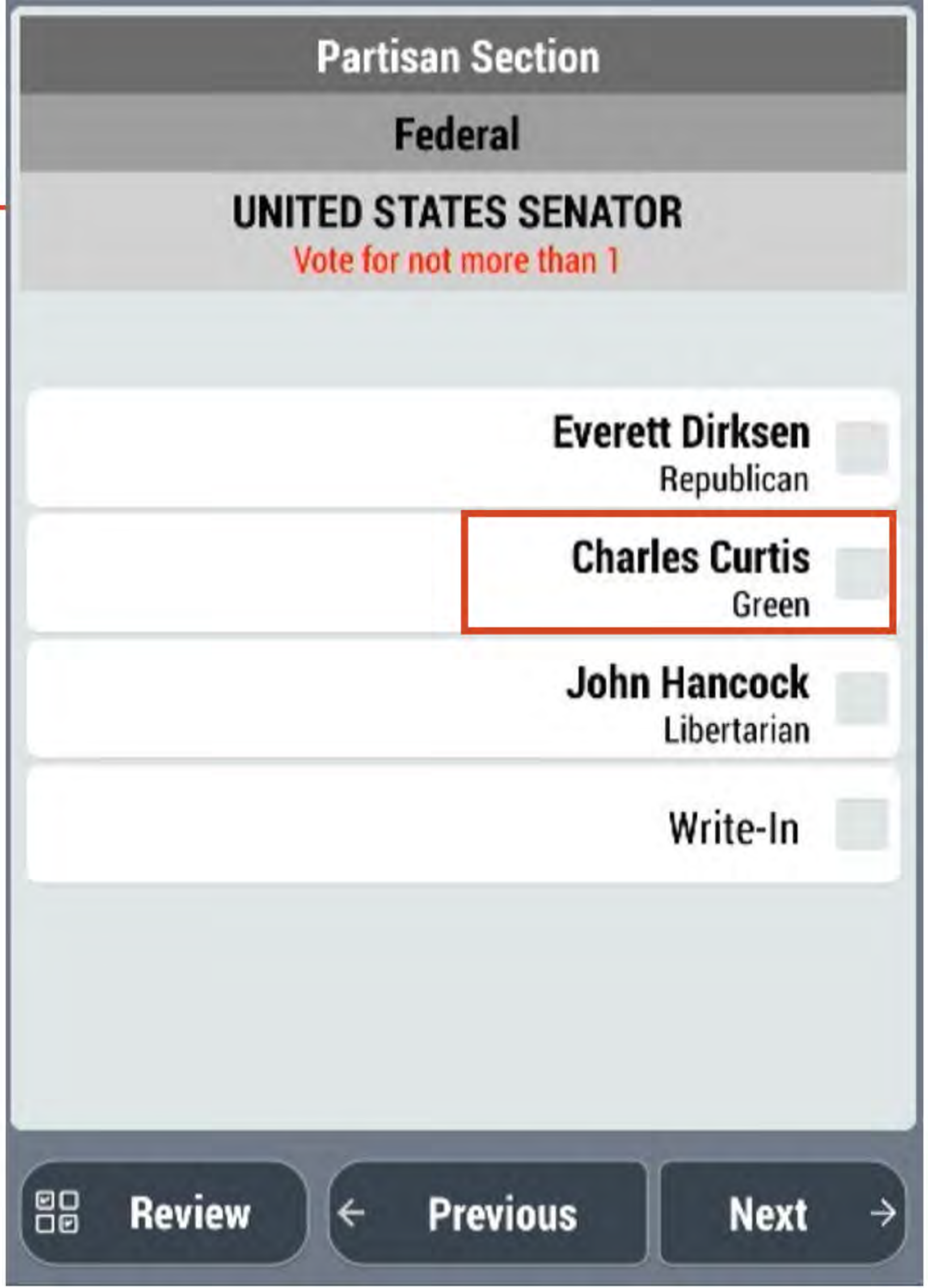


```
<#><#><b>Charles Curtis</b>
<br />
<small>Democrat</small>
```

To a different party.



```
<#><#><b>Charles Curtis</b>
<br />
<small>Green</small>
```



Partisan Section

Federal

UNITED STATES SENATOR

Vote for not more than 1

Everett Dirksen
Republican □

Charles Curtis
Green □

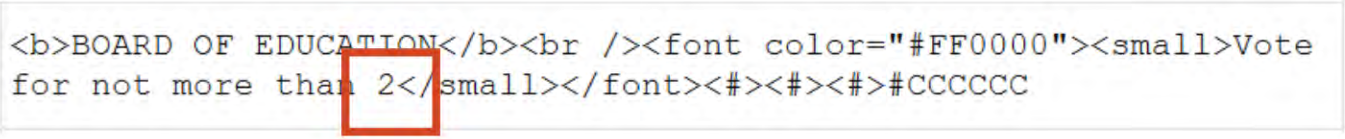
John Hancock
Libertarian □

Write-In □

Hacking the Voter

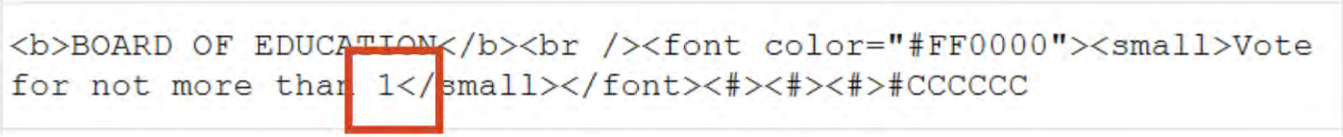
The instruction that permits two choices in a race can be changed to permit only one.

Changing the contest’s instructions

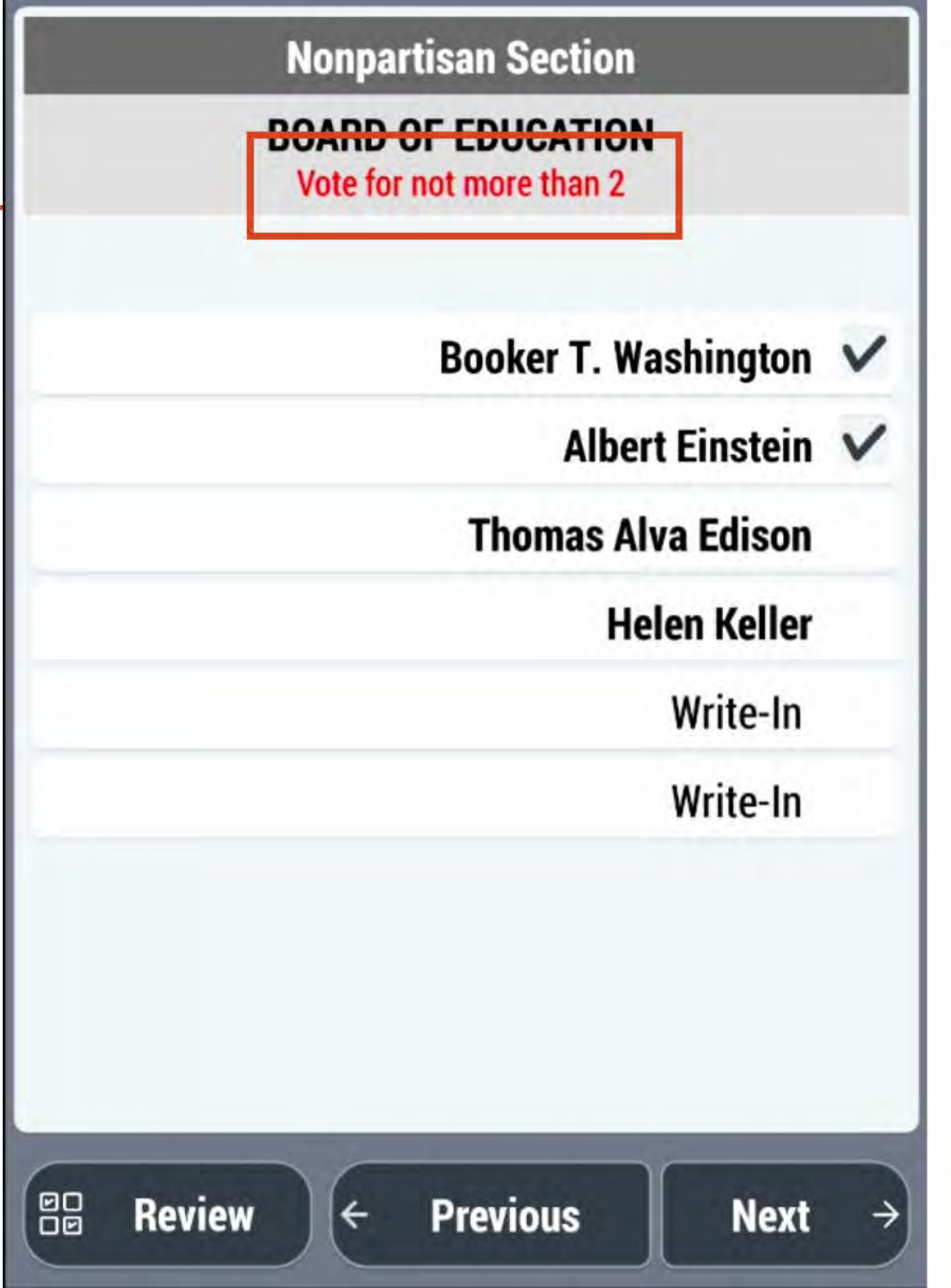


```
<b>BOARD OF EDUCATION</b><br /><font color="#FF0000"><small>Vote
for not more than 2</small></font><#><#><#>#CCCCCC
```

Although the user can still make 2 choices, it is likely that one candidate will lose votes.



```
<b>BOARD OF EDUCATION</b><br /><font color="#FF0000"><small>Vote
for not more than 1</small></font><#><#><#>#CCCCCC
```



Nonpartisan Section

BOARD OF EDUCATION

Vote for not more than 2

Booker T. Washington ✓

Albert Einstein ✓

Thomas Alva Edison

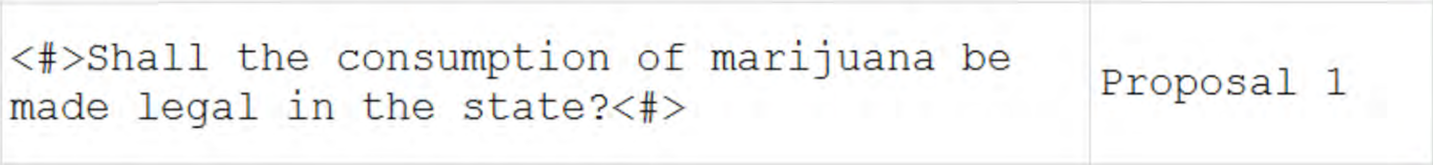
Helen Keller

Write-In

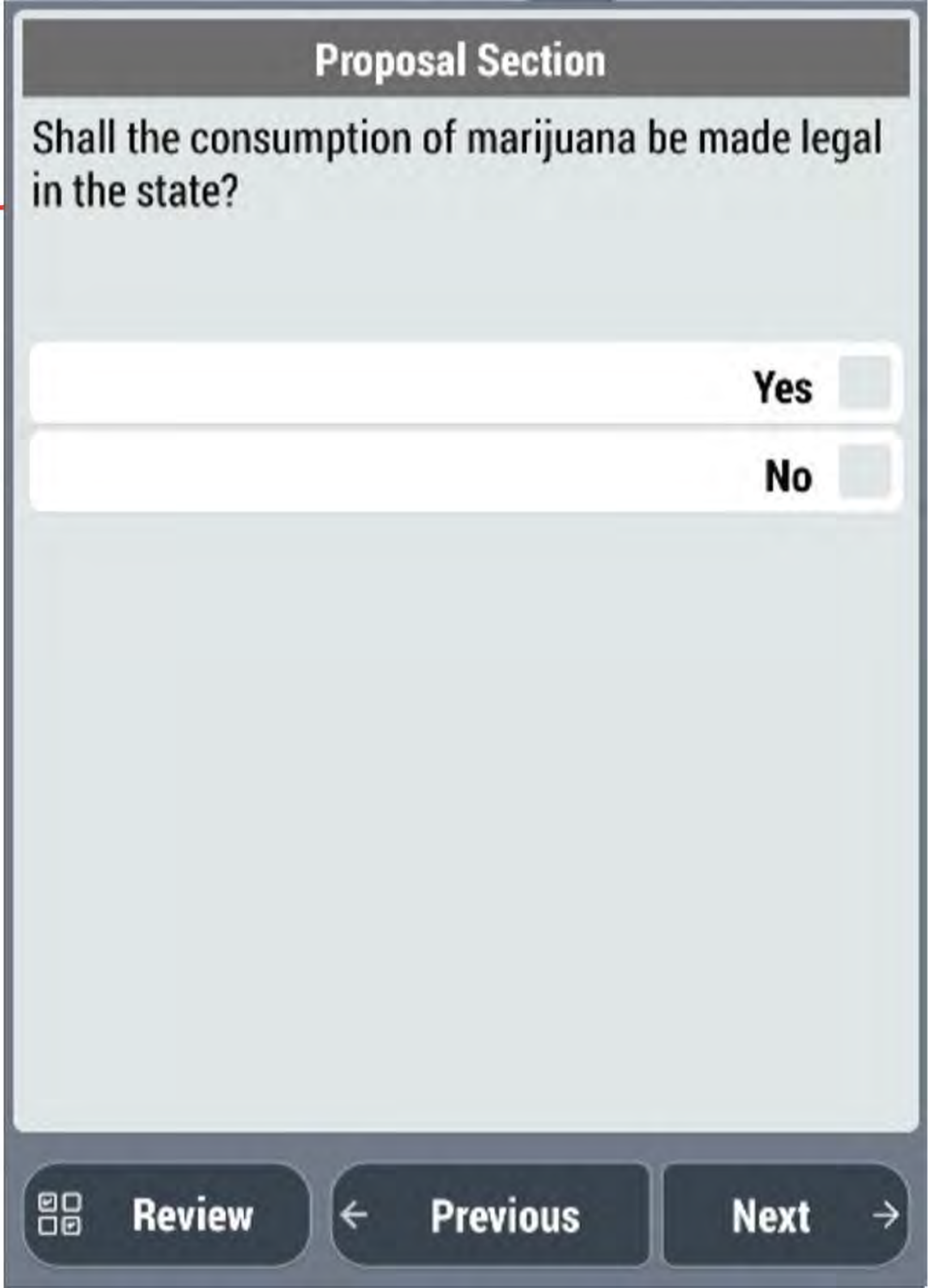
Write-In

Hacking the Voter

The text for ballot questions can be edited in a way that tricks the voter.



<#>Shall the consumption of marijuana be made legal in the state?<#>	Proposal 1



Proposal Section

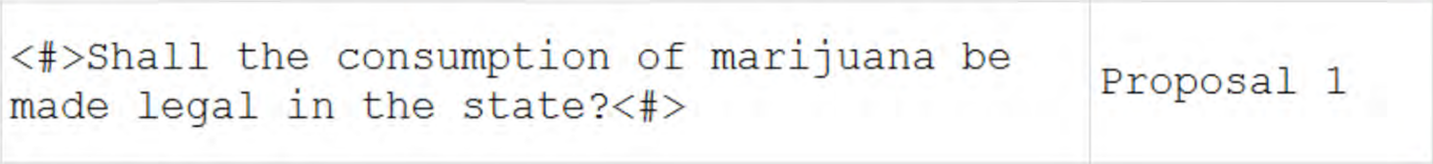
Shall the consumption of marijuana be made legal in the state?

Yes □

No □

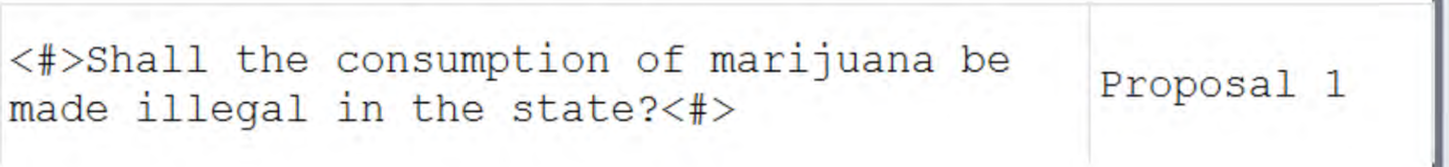
Hacking the Voter

The text for ballot questions can be edited in a way that tricks the voter.

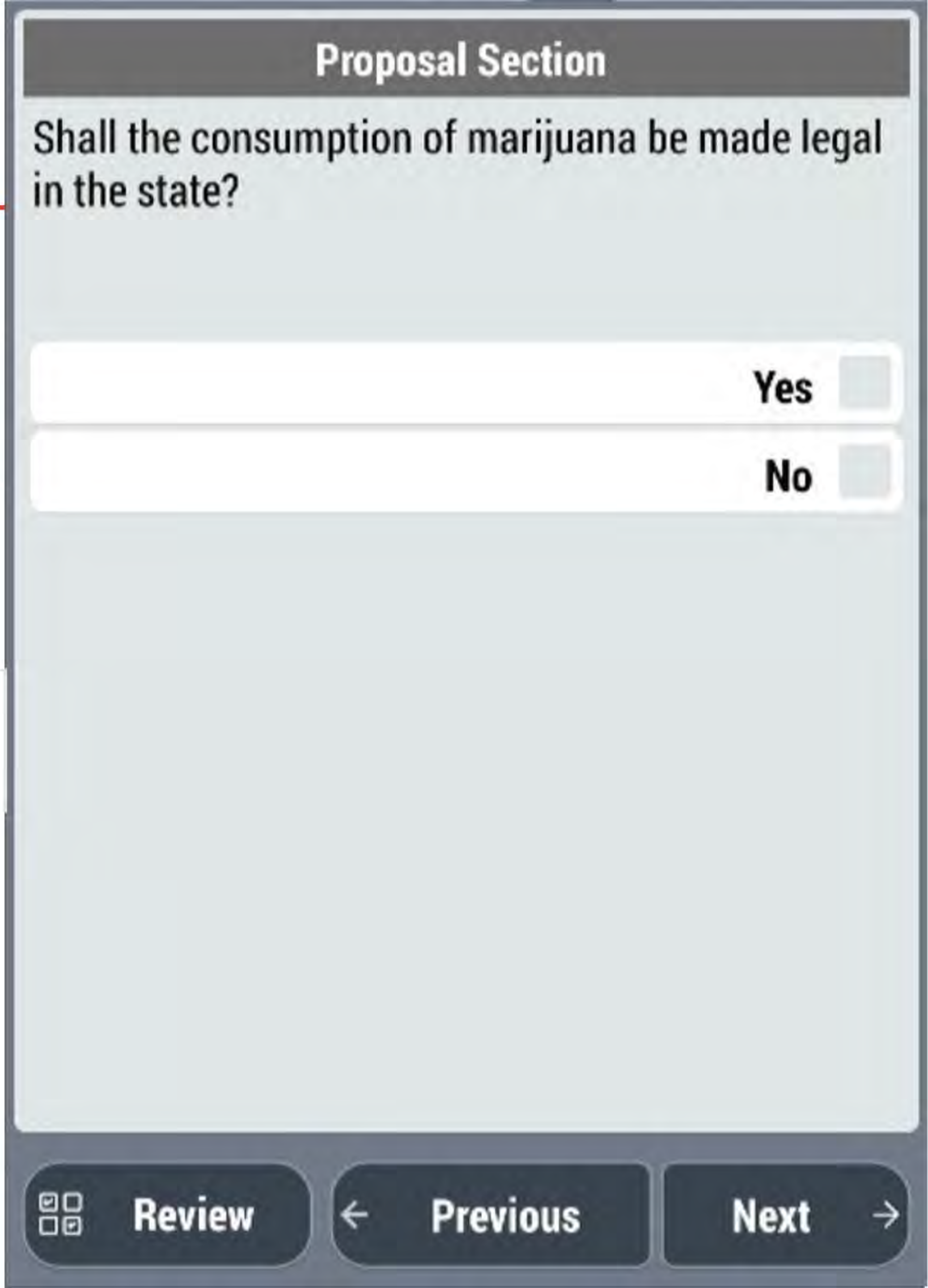


<#>Shall the consumption of marijuana be made legal in the state?<#>	Proposal 1

Changing the question to be the inverse of the official ballot question



<#>Shall the consumption of marijuana be made illegal in the state?<#>	Proposal 1



Proposal Section

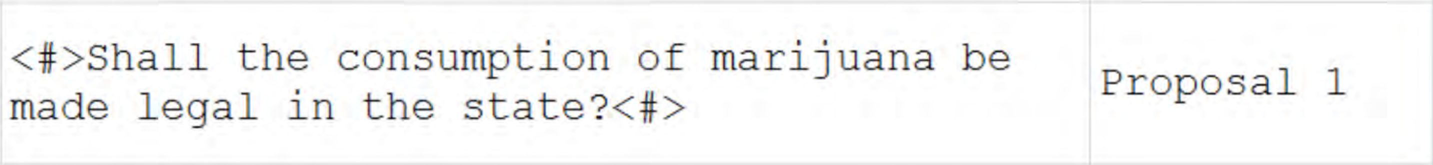
Shall the consumption of marijuana be made legal in the state?

Yes □

No □

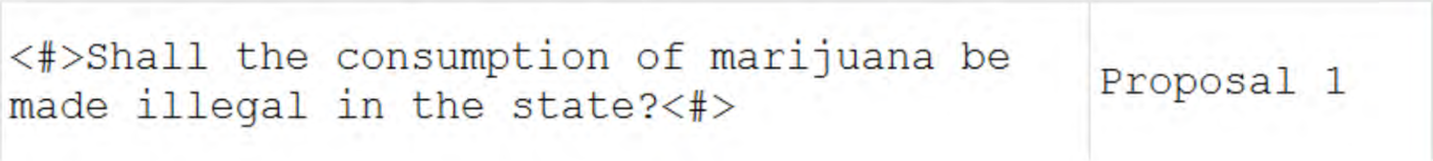
Hacking the Voter

The text for ballot questions can be edited in a way that tricks the voter.

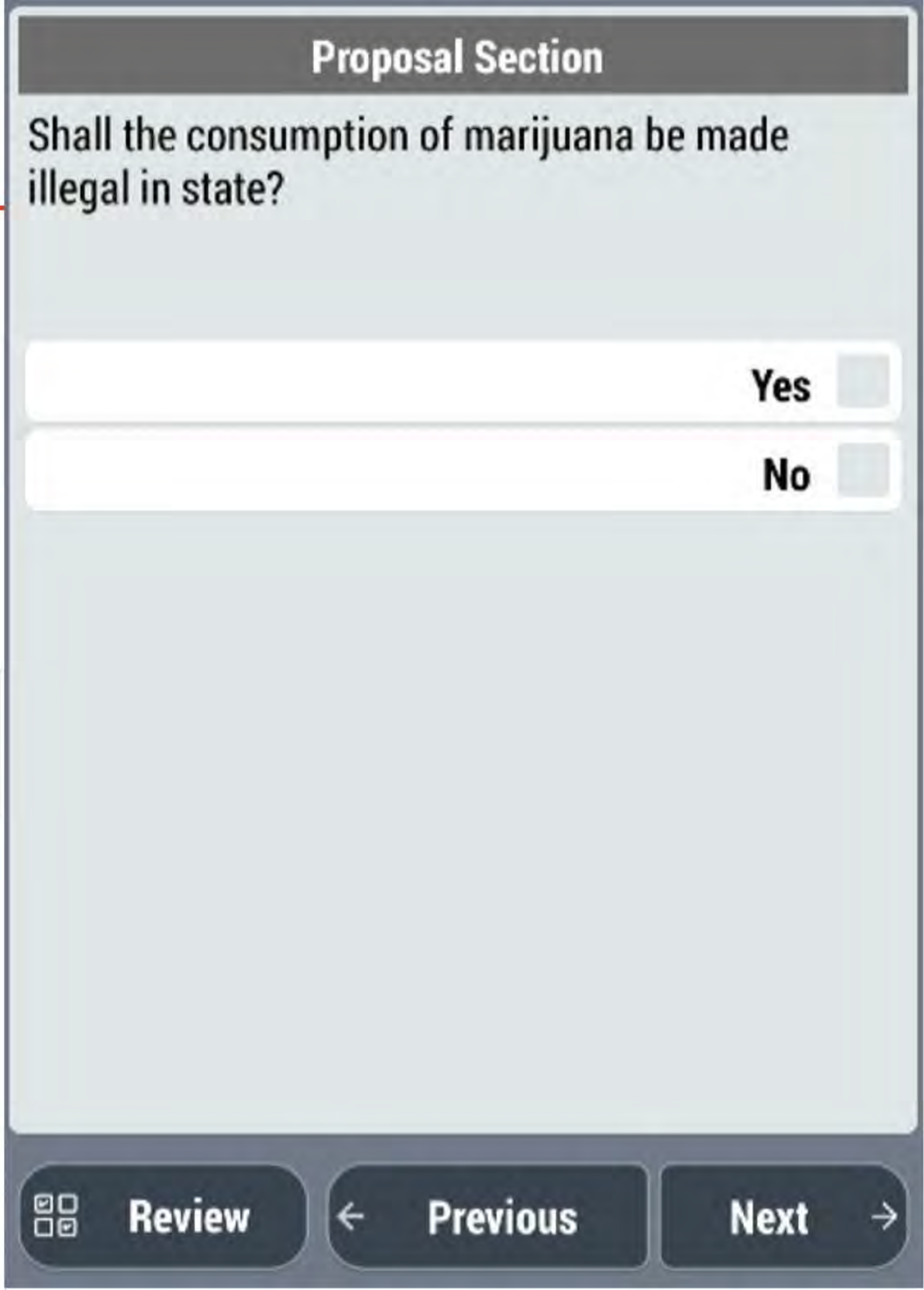


<#>Shall the consumption of marijuana be made legal in the state?<#>	Proposal 1

Changing the question to be the inverse of the official ballot question



<#>Shall the consumption of marijuana be made illegal in the state?<#>	Proposal 1



Proposal Section

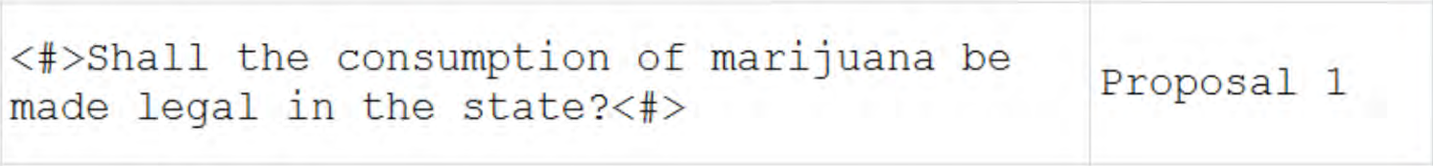
Shall the consumption of marijuana be made illegal in state?

Yes □

No □

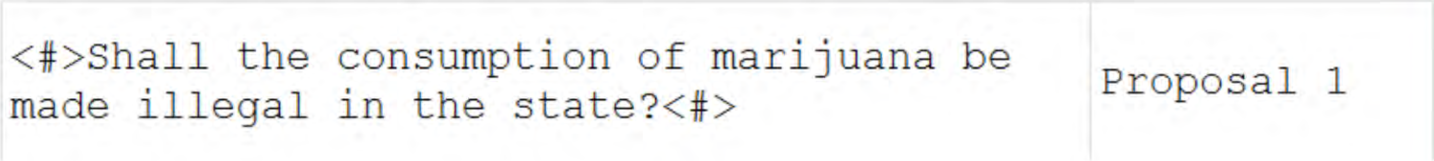
Hacking the Voter

The text for ballot questions can be edited in a way that tricks the voter.



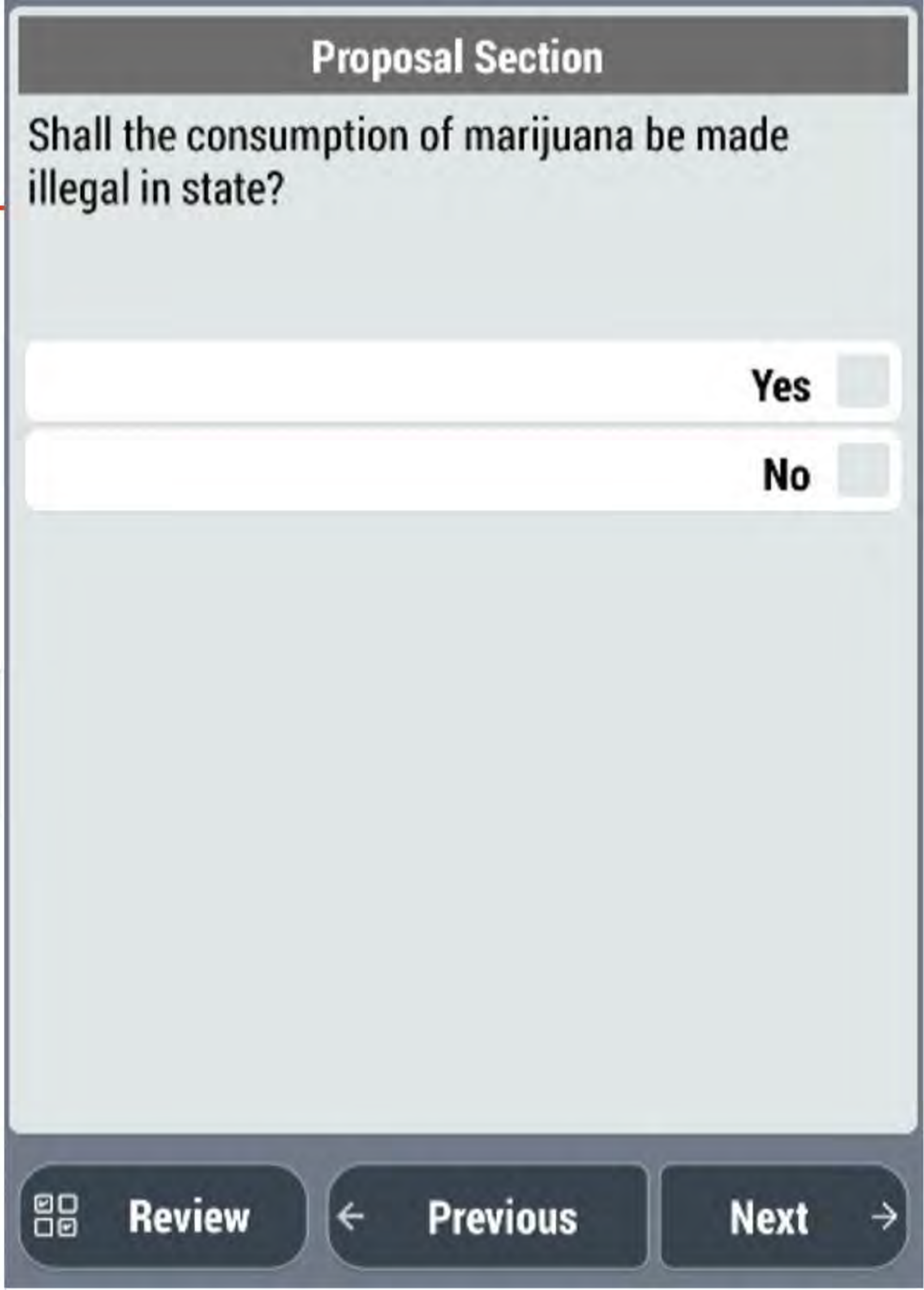
<#>Shall the consumption of marijuana be made legal in the state?<#>	Proposal 1

Changing the question to be the inverse of the official ballot question



<#>Shall the consumption of marijuana be made illegal in the state?<#>	Proposal 1

The voter will vote the opposite of their intent.



Proposal Section

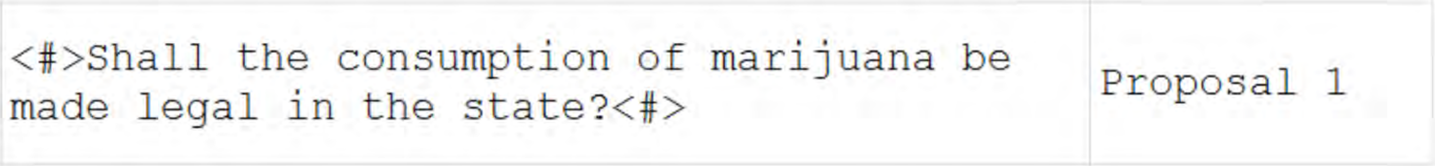
Shall the consumption of marijuana be made illegal in state?

Yes □

No □

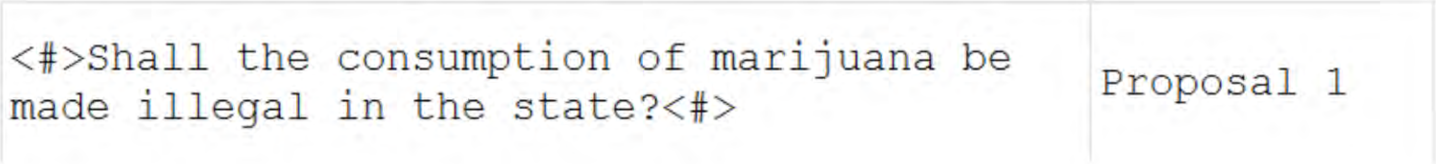
Hacking the Voter

The text for ballot questions can be edited in a way that tricks the voter.



<#>Shall the consumption of marijuana be made legal in the state?<#>	Proposal 1

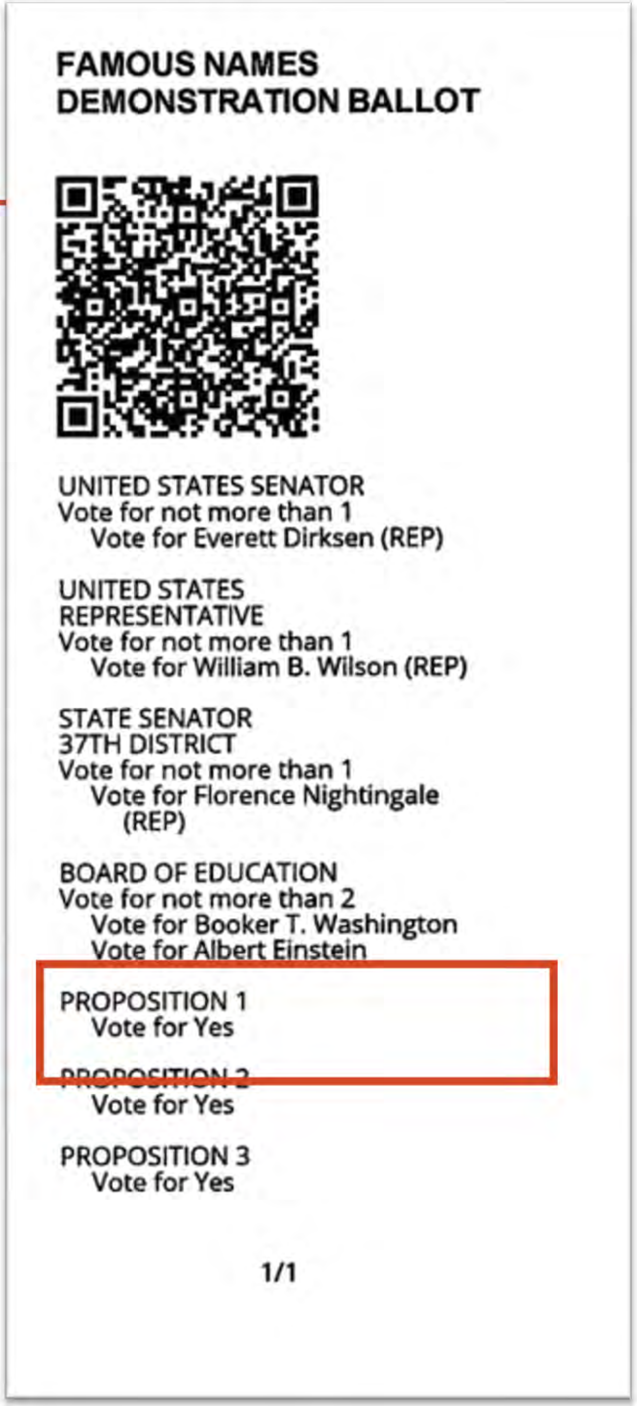
Changing the question to be the inverse of the official ballot question



<#>Shall the consumption of marijuana be made illegal in the state?<#>	Proposal 1

The voter will vote the opposite of their intent.

The printed ballot doesn't print the question, so if the voter sees the printed ballot, they will think they voted correctly



FAMOUS NAMES
DEMONSTRATION BALLOT

UNITED STATES SENATOR
Vote for not more than 1
Vote for Everett Dirksen (REP)

UNITED STATES
REPRESENTATIVE
Vote for not more than 1
Vote for William B. Wilson (REP)

STATE SENATOR
37TH DISTRICT
Vote for not more than 1
Vote for Florence Nightingale
(REP)

BOARD OF EDUCATION
Vote for not more than 2
Vote for Booker T. Washington
Vote for Albert Einstein

PROPOSITION 1
Vote for Yes

PROPOSITION 2
Vote for Yes

PROPOSITION 3
Vote for Yes

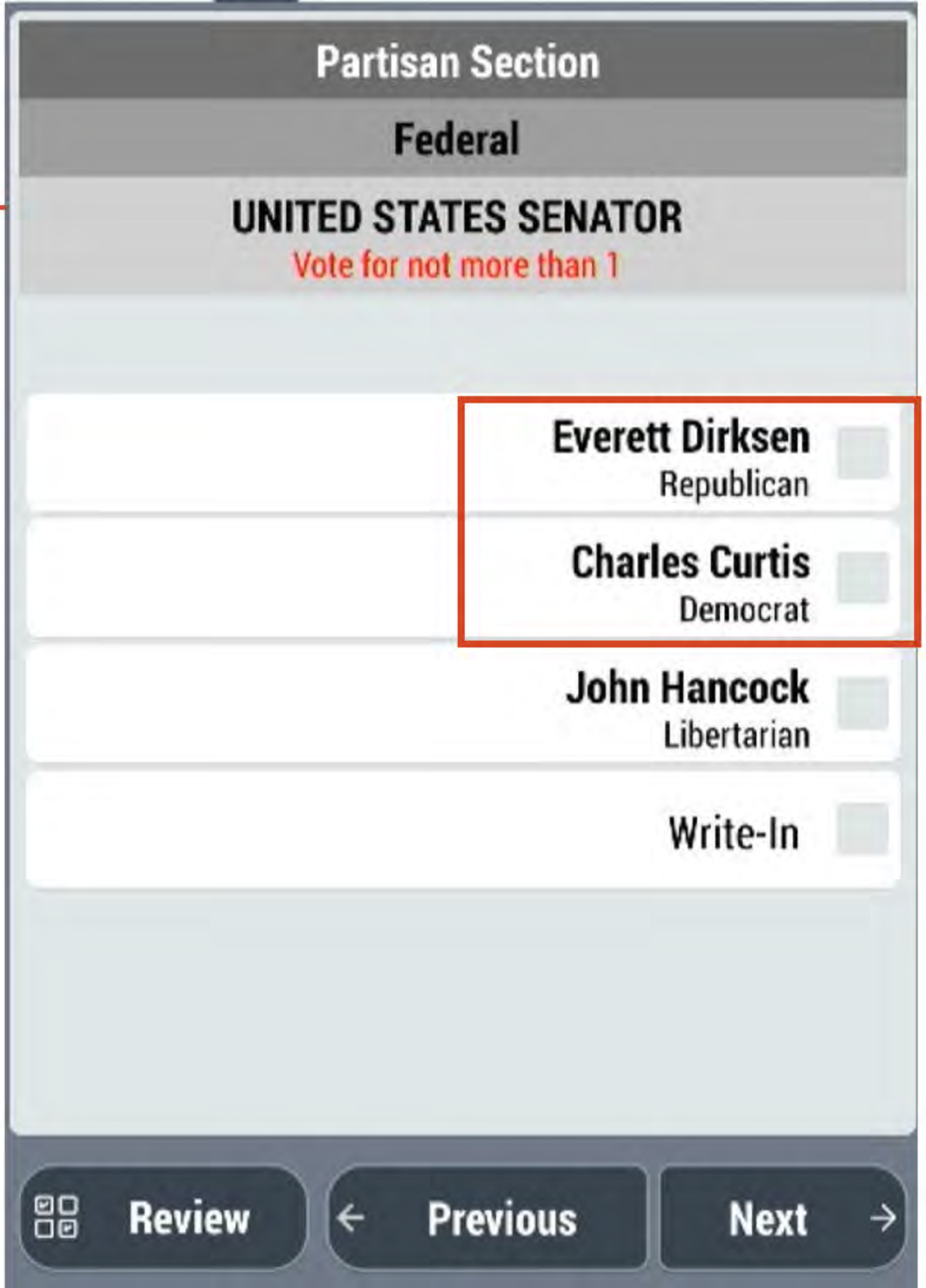
1/1

Hacking the Vote Count

Creating hacks by changing the vote that is tabulated.

Hacking the Vote Count

Switching the order of the two candidates will record the vote for the opposite candidate.



Partisan Section

Federal

UNITED STATES SENATOR

Vote for not more than 1

Everett Dirksen
Republican □

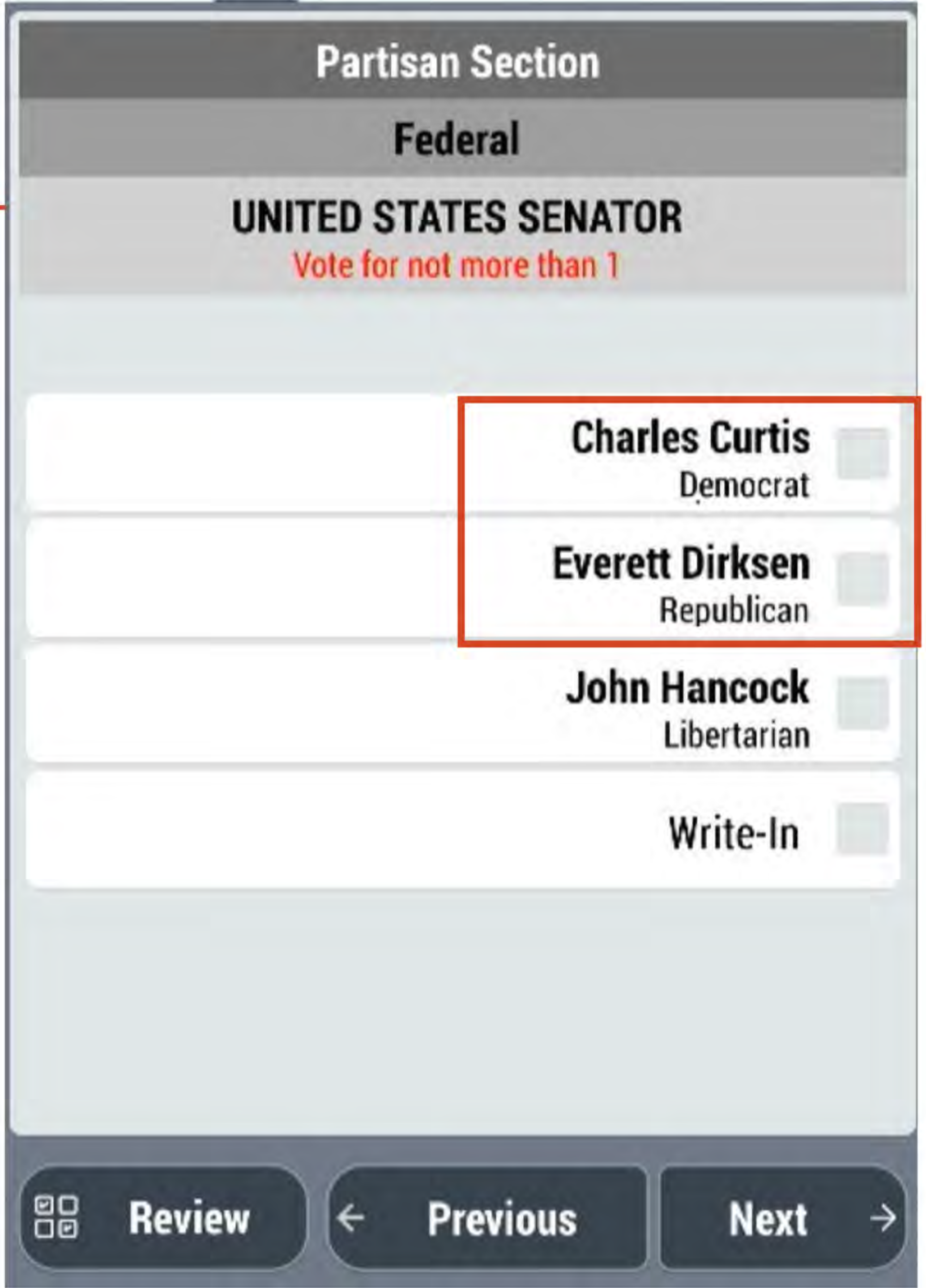
Charles Curtis
Democrat □

John Hancock
Libertarian □

Write-In □

Hacking the Vote Count

Switching the order of the two candidates will record the vote for the opposite candidate.



Partisan Section

Federal

UNITED STATES SENATOR

Vote for not more than 1

Charles Curtis
Democrat □

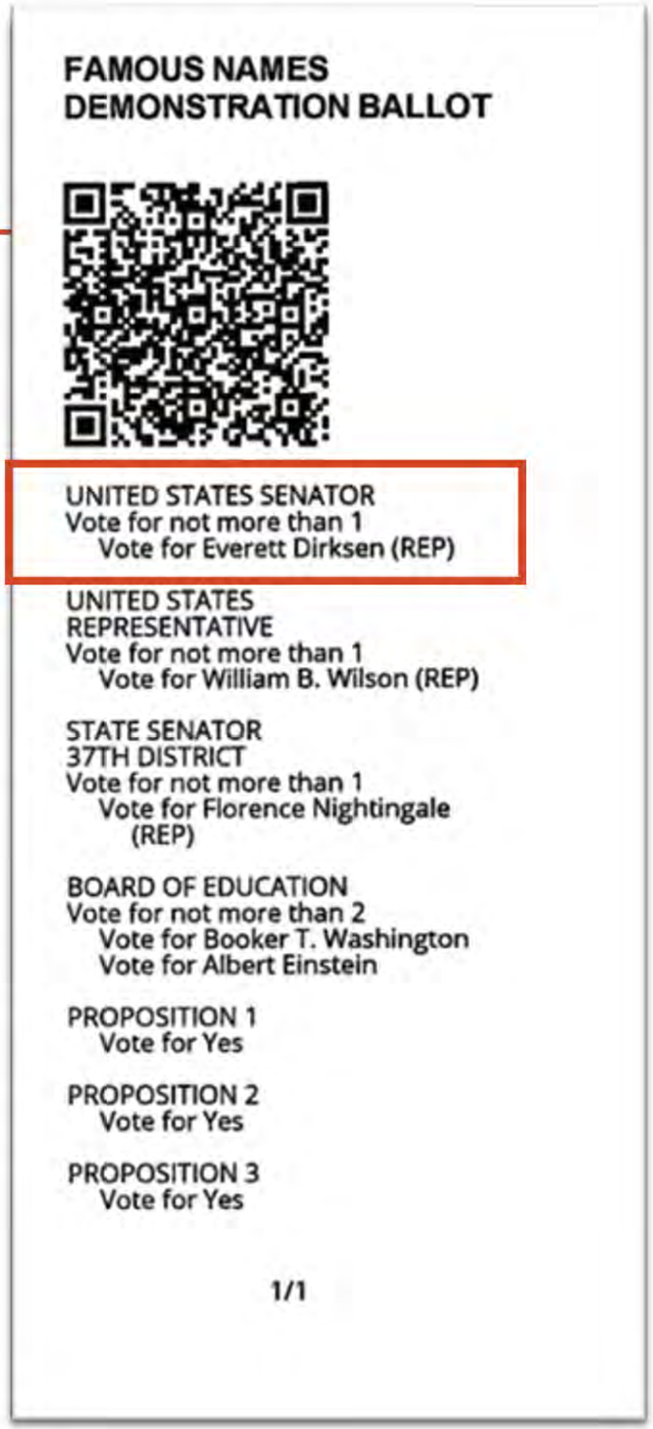
Everett Dirksen
Republican □

John Hancock
Libertarian □

Write-In □

Hacking the Vote Count

We can also swap the candidates on the printed text, so reviewing the printed ballot will not disclose the attack.



FAMOUS NAMES
DEMONSTRATION BALLOT

UNITED STATES SENATOR
Vote for not more than 1
Vote for Everett Dirksen (REP)

UNITED STATES REPRESENTATIVE
Vote for not more than 1
Vote for William B. Wilson (REP)

STATE SENATOR 37TH DISTRICT
Vote for not more than 1
Vote for Florence Nightingale (REP)

BOARD OF EDUCATION
Vote for not more than 2
Vote for Booker T. Washington
Vote for Albert Einstein

PROPOSITION 1
Vote for Yes

PROPOSITION 2
Vote for Yes

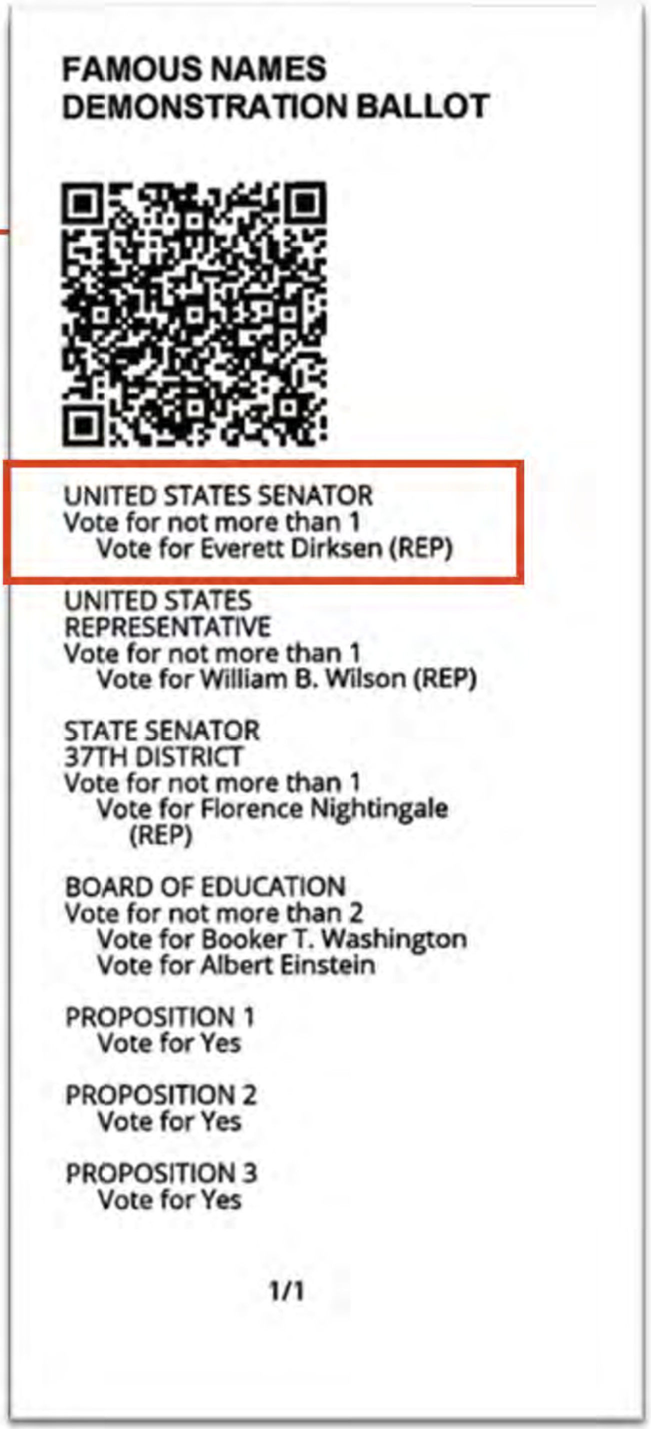
PROPOSITION 3
Vote for Yes

1/1

Hacking the Vote Count

We can also swap the candidates on the printed text, so reviewing the printed ballot will not disclose the attack.

The QR code does not change, and the wrong candidate receives the vote.



FAMOUS NAMES DEMONSTRATION BALLOT

UNITED STATES SENATOR
Vote for not more than 1
Vote for Everett Dirksen (REP)

UNITED STATES REPRESENTATIVE
Vote for not more than 1
Vote for William B. Wilson (REP)

STATE SENATOR 37TH DISTRICT
Vote for not more than 1
Vote for Florence Nightingale (REP)

BOARD OF EDUCATION
Vote for not more than 2
Vote for Booker T. Washington
Vote for Albert Einstein

PROPOSITION 1
Vote for Yes

PROPOSITION 2
Vote for Yes

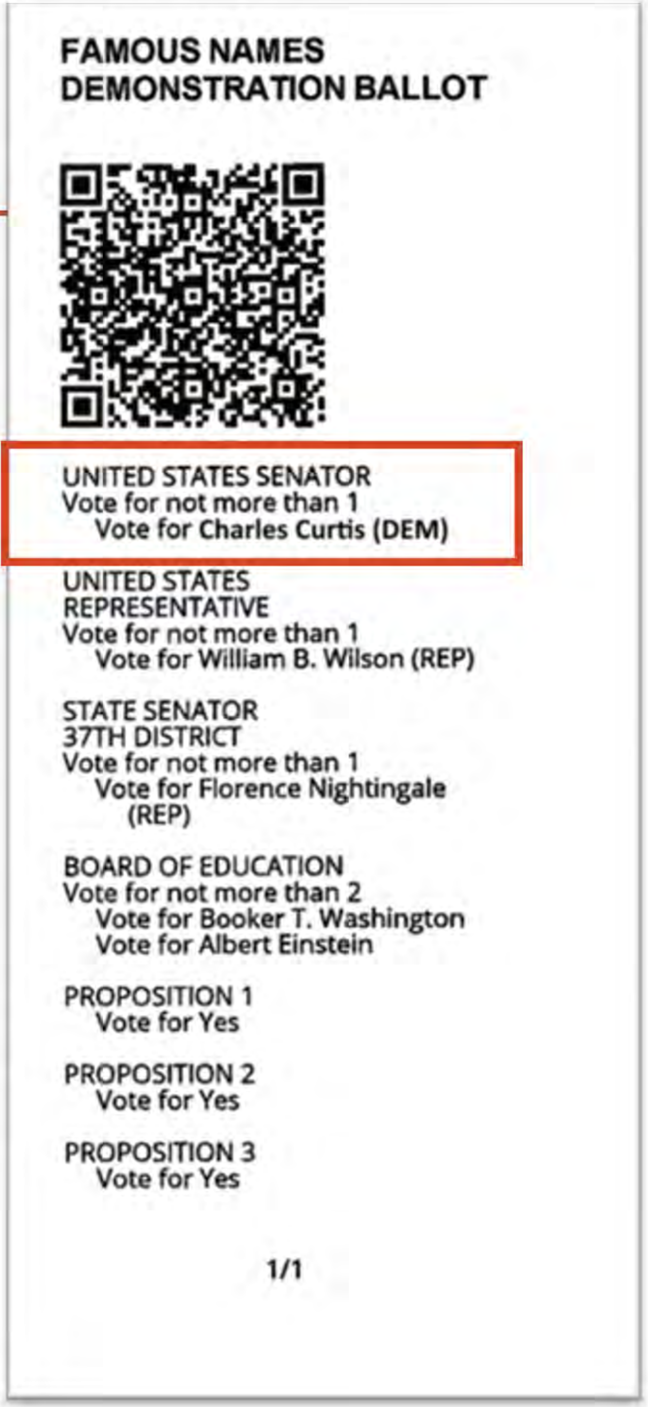
PROPOSITION 3
Vote for Yes

1/1

Hacking the Vote Count

We can also swap the candidates on the printed text, so reviewing the printed ballot will not disclose the attack.

The QR code does not change, and the wrong candidate receives the vote.



FAMOUS NAMES
DEMONSTRATION BALLOT

UNITED STATES SENATOR
Vote for not more than 1
Vote for Charles Curtis (DEM)

UNITED STATES
REPRESENTATIVE
Vote for not more than 1
Vote for William B. Wilson (REP)

STATE SENATOR
37TH DISTRICT
Vote for not more than 1
Vote for Florence Nightingale
(REP)

BOARD OF EDUCATION
Vote for not more than 2
Vote for Booker T. Washington
Vote for Albert Einstein

PROPOSITION 1
Vote for Yes

PROPOSITION 2
Vote for Yes

PROPOSITION 3
Vote for Yes

1/1

Live Demonstration of Choice Swap

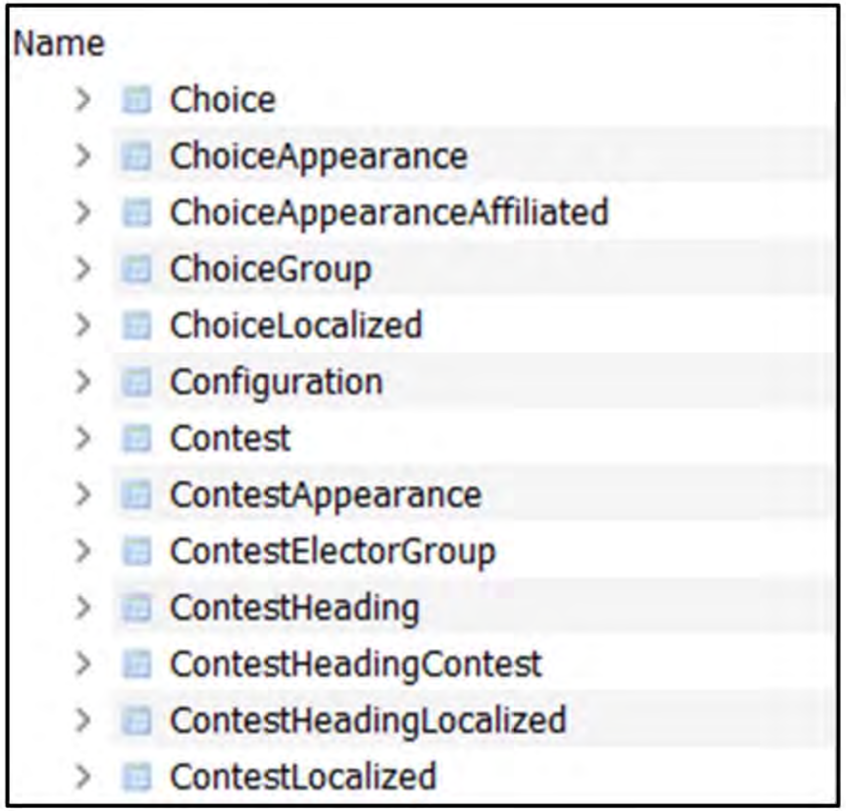
Swapping two candidates

Generic Requirements to Perform These Hacks

- Understand election definition
- Obtain AES key+IV
- Obtain ***unmodified*** election definition
- Replace with ***modified*** election definition

Generic Requirements to Perform These Hacks

- ~~Understand election definition~~
  - **SIMPLE** given publicly-available data
- Obtain AES key+IV
- Obtain ***unmodified*** election definition
- Replace with ***modified*** election definition



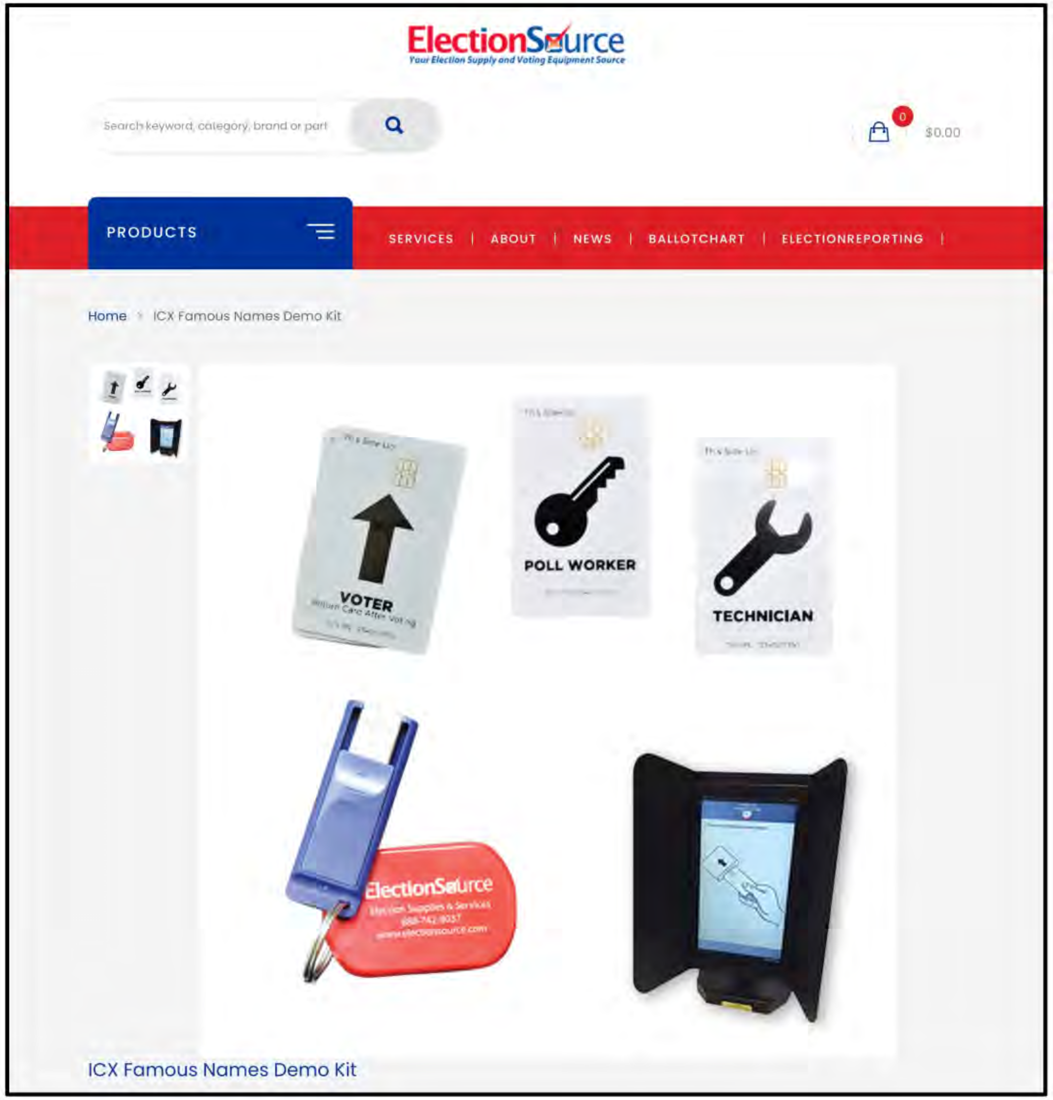
Name
- Choice
- ChoiceAppearance
- ChoiceAppearanceAffiliated
- ChoiceGroup
- ChoiceLocalized
- Configuration
- Contest
- ContestAppearance
- ContestElectorGroup
- ContestHeading
- ContestHeadingContest
- ContestHeadingLocalized
- ContestLocalized

Fulfilling Requirements for Voting Village Demo

- ~~Understand election definition~~
  - **SIMPLE** given publicly-available data
- Obtain AES key+IV
- Obtain ***unmodified*** election definition
- Replace with ***modified*** election definition

Fulfilling Requirements for Voting Village Demo

- ~~Understand election definition~~
  - **SIMPLE** given publicly-available data
- Obtain AES key+IV
  - We extracted from our purchased Poll-Worker Card
- Obtain ***unmodified*** election definition
  - We were given from demo-kit's USB
- Replace with ***modified*** election definition
  - We load the chosen election definition

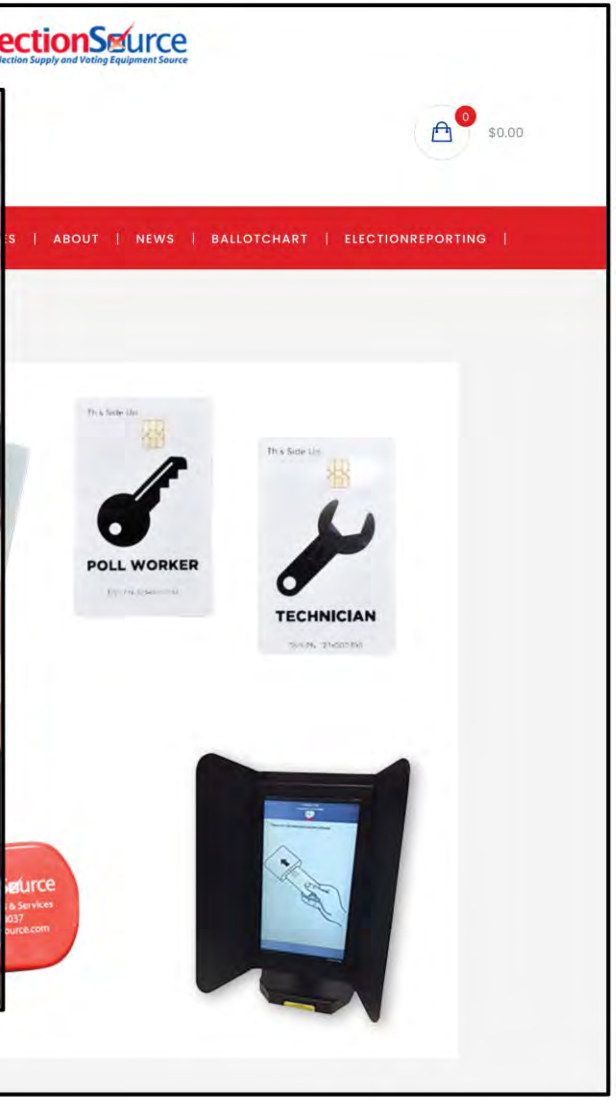

ElectionSource
Your Election Supply and Voting Equipment Source
Search keyword, category, brand or part
0
$0.00
PRODUCTS
SERVICES | ABOUT | NEWS | BALLOTCHART | ELECTIONREPORTING |
VOTER
POLL WORKER
TECHNICIAN
ElectionSource

Home > ICX Famous Names Demo Kit

ICX Famous Names Demo Kit

Fulfilling Requirements for Voting Village Demo

- ~~Understand election definition~~
  - **SIMPLE** given publicly
- Obtain AES key+IV
  - We extracted from ou
- Obtain ***unmodified*** electi
  - We were given from d
- Replace with ***modified*** ele
  - We load the chosen el


ElectionSource
Your Election Supply and Voting Equipment Source
0
$0.00
S | ABOUT | NEWS | BALLOTCHART | ELECTIONREPORTING |
POLL WORKER
TECHNICIAN

ICX Famous Names Demo Kit

What would it take to hack a real election?

- ~~Understand election definition~~
  - **SIMPLE** given publicly-available data
- Obtain AES key+IV
- Obtain ***unmodified*** election definition
- Replace with ***modified*** election definition

What would it take to hack a real election?

- ~~Understand election definition~~
  - **SIMPLE** given publicly-available data
- Obtain AES key+IV
  - We extracted from our purchased Poll-Worker Card
- Obtain ***unmodified*** election definition
  - We were given from demo-kit’s USB
- Replace with ***modified*** election definition
  - We load the chosen election definition

What would it take to hack a real election?

- ~~Understand election definition~~
  - **SIMPLE** given publicly-available data
- Obtain AES key+IV

  Poll Workers can their official

  - ~~We~~ extracted from ~~our purchased~~ Poll-Worker Card
- Obtain ***unmodified*** election definition

  Poll Workers configuration

  - ~~We~~ were given from ~~demo-kit's~~ USB
- Replace with ***modified*** election definition

  Poll Workers

  - ~~We~~ load the chosen election definition

What would it take to hack a <insert scenario here>?

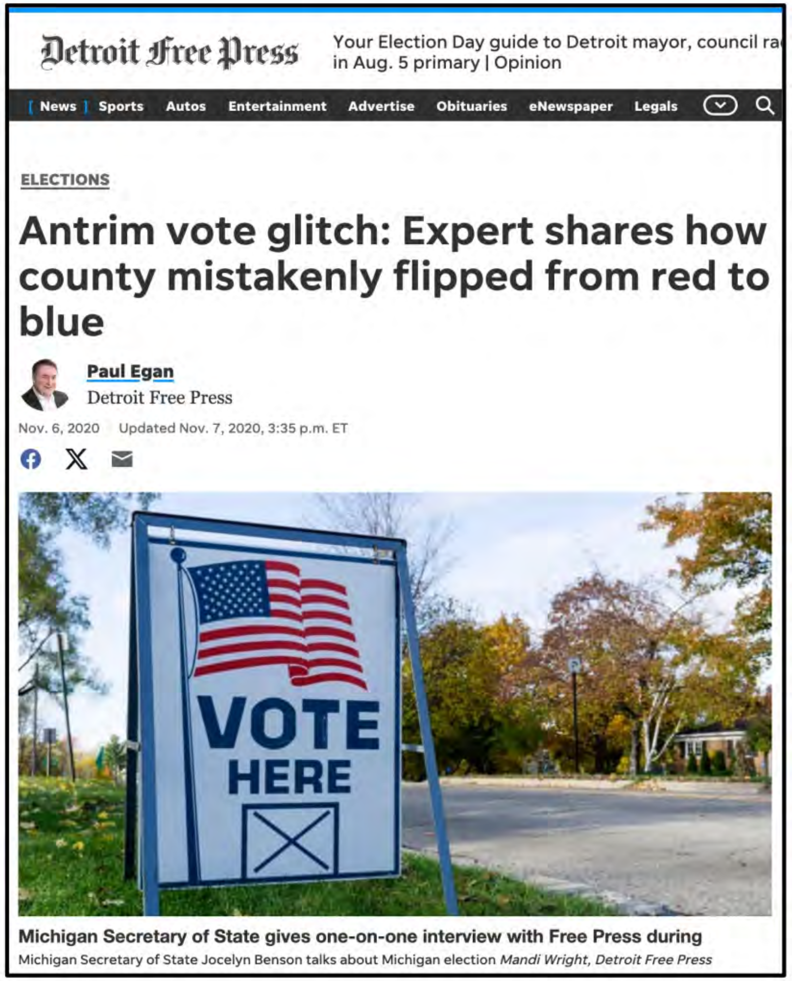
- ~~Understand election definition~~
    - **SIMPLE** given publicly-available data
- Obtain AES key+IV
- Obtain ***unmodified*** election definition
- Replace with ***modified*** election definition

What would it take to hack a <insert scenario here>?

- ~~Understand election definition~~
  - **SIMPLE** given publicly-available data
- Obtain AES key+IV
  - Located on EMS, every PW-Card, and every ICX
- Obtain ***unmodified*** election definition
  - Located on EMS, setup USBs, and every ICX
- Replace with ***modified*** election definition
  - Modify during EMS creation/export
  - Swap USB drive before pre-election configuration
  - Replace on ICXes in-transit, during over-nights, or during the voting period

Resolving Incorrect Definition-Related Errors

- Real-World Examples
  - Antrim County, MI (2020)
  - Dekalb County, GA (2022)



Your Election Day guide to Detroit mayor, council ra
in Aug. 5 primary | Opinion

ELECTIONS

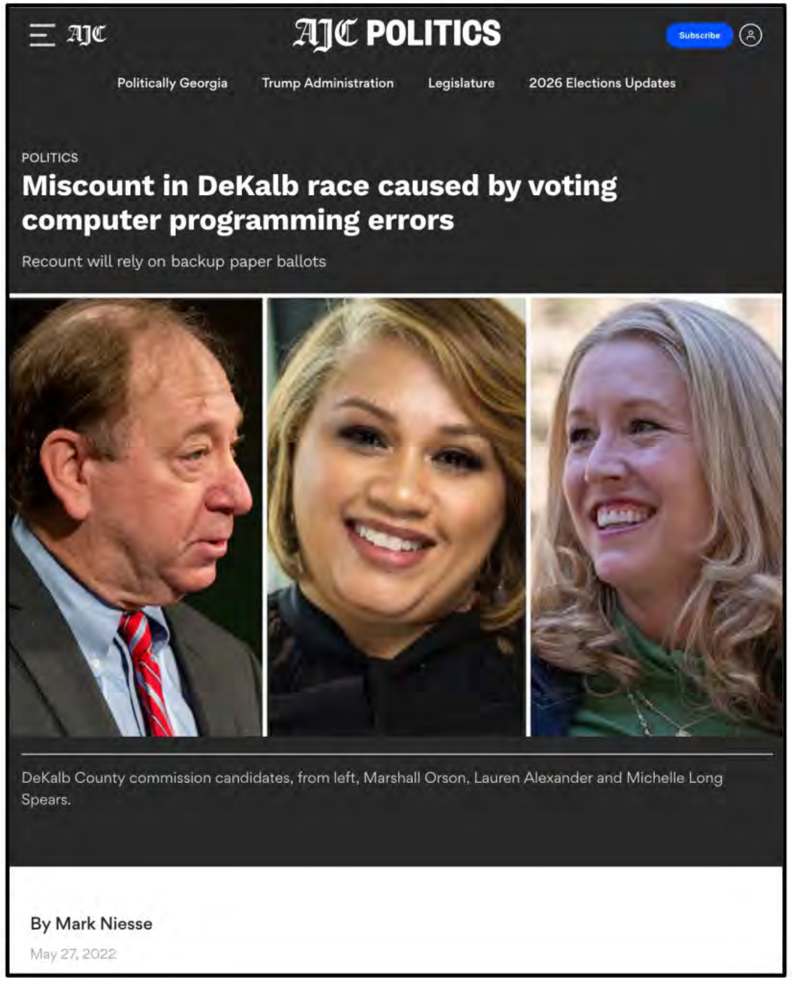
Antrim vote glitch: Expert shares how county mistakenly flipped from red to blue

Paul Egan
Detroit Free Press

Nov. 6, 2020 Updated Nov. 7, 2020, 3:35 p.m. ET

Michigan Secretary of State gives one-on-one interview with Free Press during

Michigan Secretary of State Jocelyn Benson talks about Michigan election *Mandi Wright, Detroit Free Press*



POLITICS

Miscount in DeKalb race caused by voting computer programming errors

Recount will rely on backup paper ballots

DeKalb County commission candidates, from left, Marshall Orson, Lauren Alexander and Michelle Long Spears.

By Mark Niesse

May 27, 2022

Resolving Incorrect Definition-Related Errors

- Real-World Examples
  - Antrim County, MI (2020)
  - Dekalb County, GA (2022)
- Source: **Universal** election definition conflict
- Behavior: **All votes** for “Alice” given to “Bob” in known polling locations using **specific ballot-styles**
- Recovery: Find all instances of affected ballots and remap votes to correct candidate

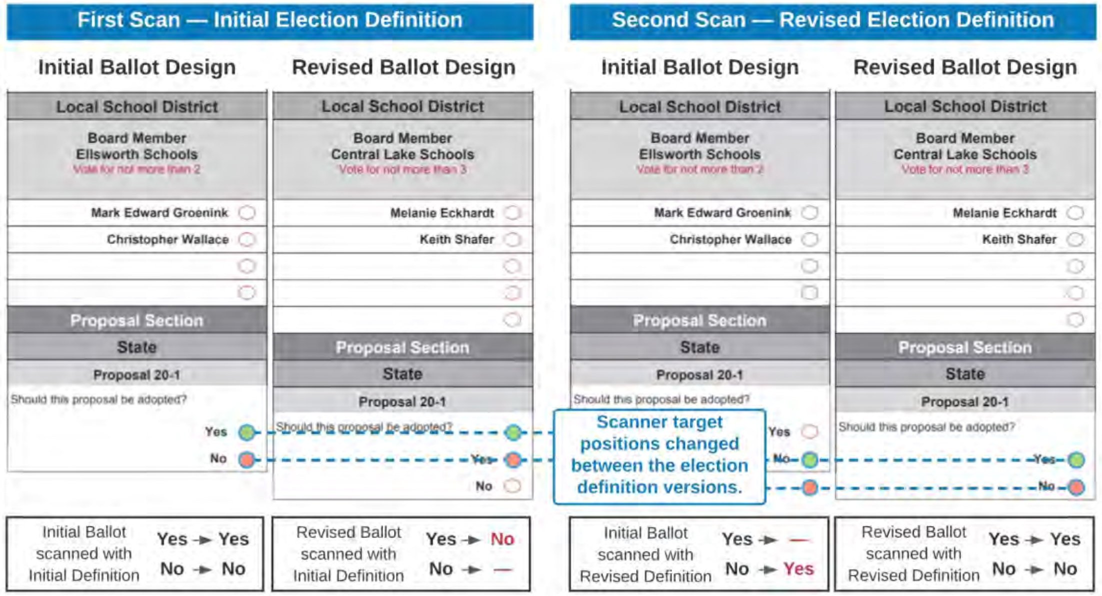
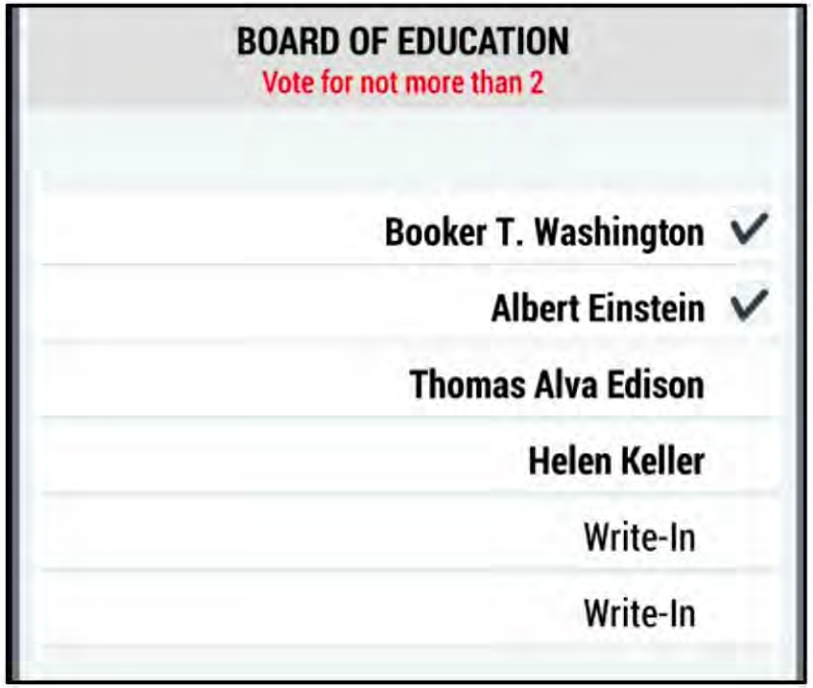

First Scan — Initial Election Definition
Second Scan — Revised Election Definition
Initial Ballot Design
Revised Ballot Design
Local School District
Board Member Ellsworth Schools
Vote for not more than 2
Board Member Central Lake Schools
Vote for not more than 3
Mark Edward Groenink
Christopher Wallace
Melanie Eckhardt
Keith Shafer
Proposal Section
State
Proposal 20-1
Should this proposal be adopted?
Yes
No
Scanner target positions changed between the election definition versions.
Initial Ballot scanned with Initial Definition
Yes → Yes
No → No
Revised Ballot scanned with Initial Definition
Yes → No
No → —
Initial Ballot scanned with Revised Definition
Yes → —
No → Yes
Revised Ballot scanned with Revised Definition
Yes → Yes
No → No

Figure 3: Central Lake scanned ballots twice, first with the initial election definition (*left*) and then with the revised election definition (*right*). Some ballots used the initial design and others used the revised design, in which targets for State Proposal 20-1 shifted down by one row. In both scans, Proposal 20-1 selections on ballots that did not match the election definition in use were miscounted, as shown in boxes at bottom.

Halderman, J. Alex. "The Antrim County 2020 Election Incident: An Independent Forensic Investigation.” *31st USENIX Security Symposium (USENIX Security 22)*. 2022.

Daunting Recovery: Confusing the Voter

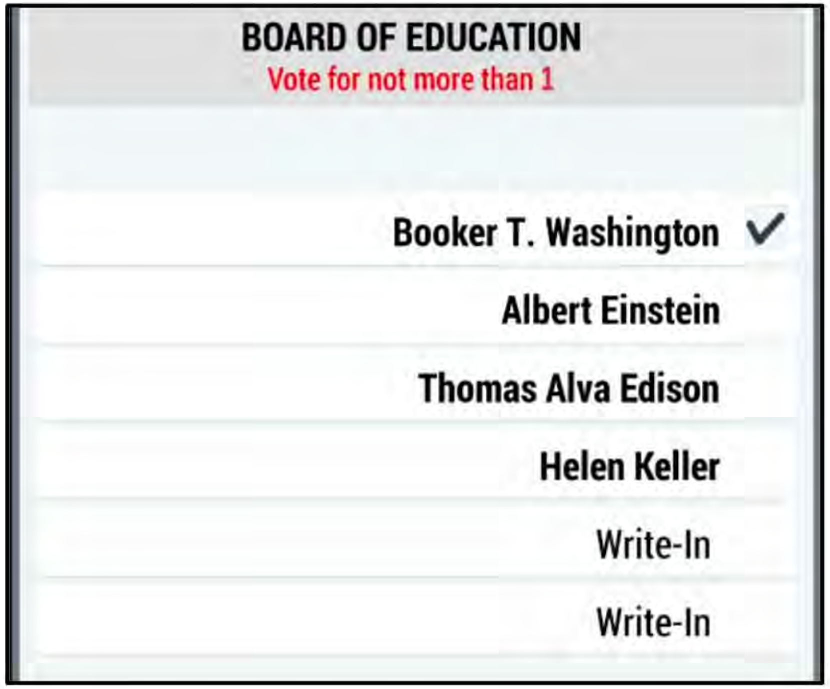
<u>Unmodified</u>



BOARD OF EDUCATION
Vote for not more than 2

Booker T. Washington ✓
Albert Einstein ✓
Thomas Alva Edison
Helen Keller
Write-In
Write-In

<u>Modified</u>



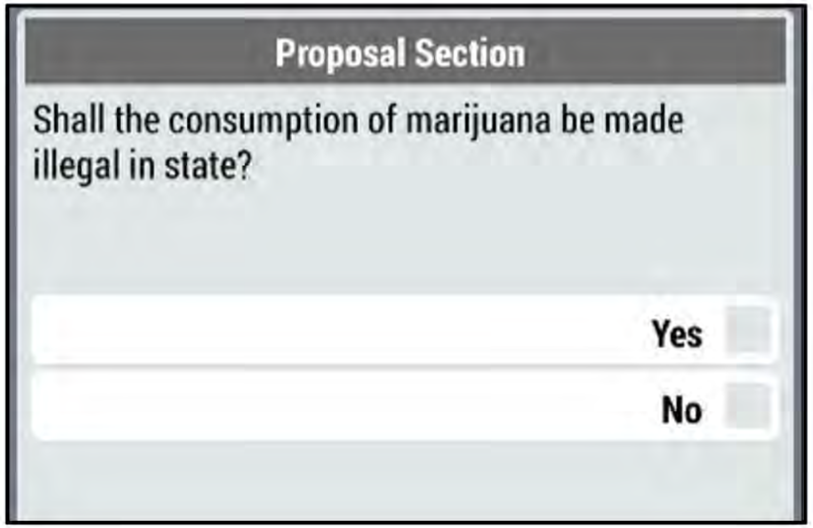
BOARD OF EDUCATION
Vote for not more than 1

Booker T. Washington ✓
Albert Einstein
Thomas Alva Edison
Helen Keller
Write-In
Write-In

- How many machines had the modified definition?
- How many people had the unmodified definition but *chose* to under-vote their ballot?
- How many people under-voted their ballot *only* because the ICX wouldn't allow them to pick two?
- How many people had the unmodified definition and would have *chosen* to under-vote regardless?

Daunting Recovery: Confusing the Voter

<u>Unmodified</u>



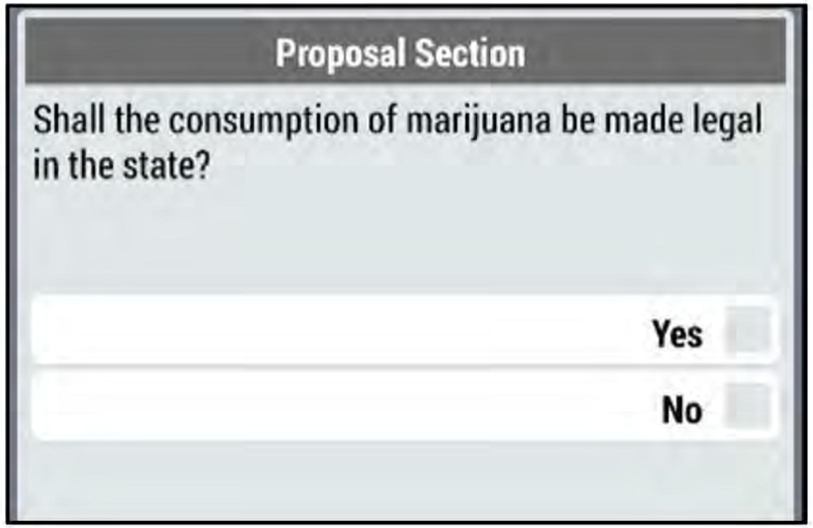
Proposal Section

Shall the consumption of marijuana be made illegal in state?

Yes □

No □

<u>Modified</u>



Proposal Section

Shall the consumption of marijuana be made legal in the state?

Yes □

No □

- How many machines had the modified definition?
- How many people answered based on the modified text?
- How many people answered based on the *expected* text?

- What ballots are associated with the correct text?
- What ballots are associated with the modified text?

Root-Cause (opinion): Insecure Architecture, Design, and Implementation

- Chose to use entirely independent elements for different contexts
  - On-screen- and print-names are different fields in different tables with different encoding
- Chose to use symmetric cryptography where need asymmetric cryptography
  - Anyone who can validate can also create
- Chose to use single set of universal and widely-spread cryptographic secrets
  - AES Key+IV

What is the solution?

NOT more computers/touchscreens.

-Hand marked ballots

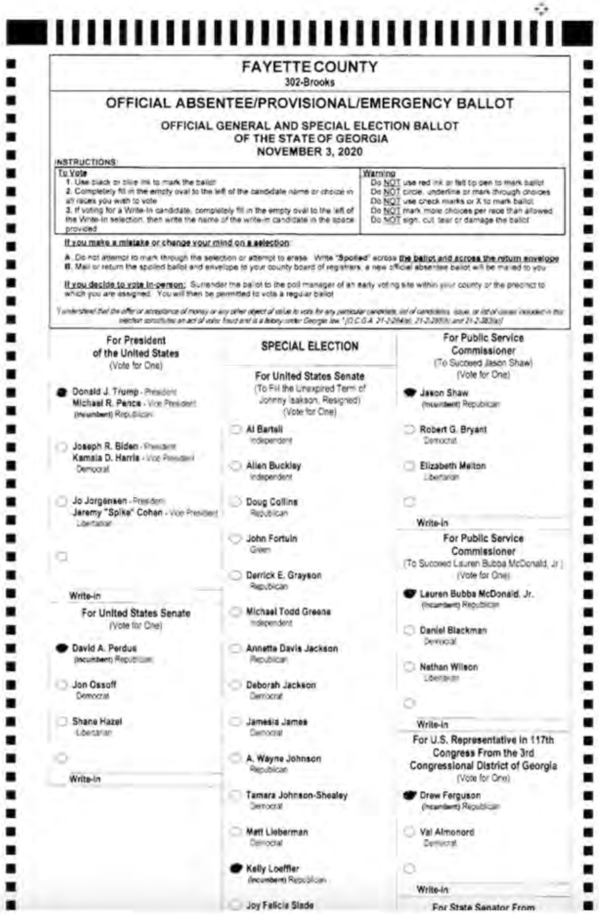
(They don't hack the voter.)

-Counted by tabulator/scanner

(They could hack the vote count.)

-Audited by hand using RLA (statistical sampling)

Significant Vote Count Hacks corrected



FAYETTE COUNTY
302-Brooks

OFFICIAL ABSENTEE/PROVISIONAL/EMERGENCY BALLOT

OFFICIAL GENERAL AND SPECIAL ELECTION BALLOT
OF THE STATE OF GEORGIA
NOVEMBER 3, 2020

INSTRUCTIONS:

To Vote	Warning
1. Use black or blue ink to mark the ballot 2. Completely fill in the empty oval to the left of the candidate name or choice in all races you wish to vote 3. If voting for a Write-in candidate, completely fill in the empty oval to the left of the Write-in selection, then write the name of the write-in candidate in the space provided	Do NOT use red ink or felt tip pen to mark ballot Do NOT circle, underline or mark through choices Do NOT use check marks or X to mark ballot Do NOT mark more choices per race than allowed Do NOT sign, cut, tear or damage the ballot

If you make a mistake or change your mind on a selection:

A. Do not attempt to mark through the selection or attempt to erase. Write "Spoiled" across the ballot and across the return envelope
B. Mail or return the spoiled ballot and envelope to your county board of registrars, a new official absentee ballot will be mailed to you

If you decide to vote in-person: Surrender the ballot to the poll manager of an early voting site within your county or the precinct to which you are assigned. You will then be permitted to vote a regular ballot

"I understand that the offer or acceptance of money or any other object of value to vote for any particular candidate, list of candidates, issue, or list of issues included in this election constitutes an act of voter fraud and is a felony under Georgia law." (O.C.G.A. 21-2-284(e), 21-2-285(h) and 21-2-383(a))

For President
of the United States
(Vote for One)

● Donald J. Trump - President
Michael R. Pence - Vice President
(Incumbent) Republican

○ Joseph R. Biden - President
Kamala D. Harris - Vice President
Democrat

○ Jo Jorgensen - President
Jeremy "Spike" Cohen - Vice President
Libertarian

○
Write-in

For United States Senate
(Vote for One)

● David A. Perdue
(Incumbent) Republican

○ Jon Ossoff
Democrat

○ Shane Hazel
Libertarian

○
Write-in

SPECIAL ELECTION

For United States Senate
(To Fill the Unexpired Term of
Johnny Isakson, Resigned)
(Vote for One)

○ Al Bartell
Independent

○ Allen Buckley
Independent

○ Doug Collins
Republican

○ John Fortuin
Green

○ Derrick E. Grayson
Republican

○ Michael Todd Greene
Independent

○ Annette Davis Jackson
Republican

○ Deborah Jackson
Democrat

○ Jamesia James
Democrat

○ A. Wayne Johnson
Republican

○ Tamara Johnson-Shealey
Democrat

○ Matt Lieberman
Democrat

● Kelly Loeffler
(Incumbent) Republican

○ Joy Felicia Slade

For Public Service
Commissioner
(To Succeed Jason Shaw)
(Vote for One)

● Jason Shaw
(Incumbent) Republican

○ Robert G. Bryant
Democrat

○ Elizabeth Melton
Libertarian

○
Write-in

For Public Service
Commissioner
(To Succeed Lauren Bubba McDonald, Jr.)
(Vote for One)

● Lauren Bubba McDonald, Jr.
(Incumbent) Republican

○ Daniel Blackman
Democrat

○ Nathan Wilson
Libertarian

○
Write-in

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

● Drew Ferguson
(Incumbent) Republican

○ Val Almonord
Democrat

○
Write-in

For State Senator From

Q&A

Continued in Session II— (VV Lab next Door)

Technical details on our hacks

Drew Springall– Presenting

Phillip Davis- Presenting

Will Whitley-Assisting

Dominion Touchscreen: Simple Hacks and Daunting Recoveries

Phillip Davis, Marilyn Marks, & Drew Springall