Perspectives on End-to-End Verifiable Voting Systems (E2EV):

Results from Interviews with Election Experts

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Kristen Greene, Ph.D.
Shanée Dawkins, Ph.D.

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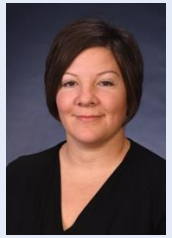
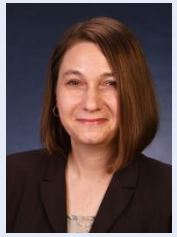
Research Team



Kristen Greene
Cognitive Scientist

Shanée Dawkins
Computer Scientist



Julie Haney
Human-Centered Cybersecurity Expert

Mary Theofanos
Computer Scientist

Jody Jacobs
Computer Scientist

Sandra Spickard Prettyman
Qualitative Research Expert

Kristin Koskey
Qualitative Research Expert

Accessibility and Human Factors Team

Gema Howell
Computer Security Expert

Noah Waller
Cryptography Expert

Andrew Regenscheid
Cryptography Expert

Cybersecurity Team (SMEs)

What we did - Motivation

2022 EAC-NIST-NCCoE E2EV Workshop: The Path to End-to-End Verifiable Protocols for Voting Systems

What do election officials think of E2EV and the future of elections?

What are their perceptions of E2EV with respect to

- Accessibility
- Cybersecurity
- Usability

Getting Started – Observations

- Use of E2EV in local election, College Park, MD
- Town hall and election day

Qualitative Research Study

What we did - Qualitative Research

In-depth research interviews that follow **rigorous and repeatable methodology** from start to finish

Not just “talking to people”

Trained interviewer follows semi-structured interview protocol

Interview is recorded ➔ professionally transcribed ➔ rigorously tagged and analyzed by team ➔ find overarching themes across the data

Applied extensive team experience with qualitative research methods

Why It's Important

- New voting technologies, like E2EV voting systems, are being proposed as **solutions** for increasing **voter trust and confidence** in elections
- It is unclear if these and/or other non-technological solutions may meet election officials' needs and address voter trust and confidence

Research Questions

What are election experts' views on **needs**, **challenges**, and **solutions** with respect to administering elections and ensuring **voter trust** and **confidence**?

What are election experts' perceptions and understanding of **E2EV**?

Conducting the study

- Develop research questions ☑
- Develop interview protocol ☑
- Apply expert protocol reviewer feedback ☑
- Obtain human subjects research approval ☑
- Pilot interview protocol ☑
- Conduct interviews ☑
- Analyze qualitative research data ☑
- Document findings ☑
- Publish results

Coming soon!

Interview Questions: Expert Perspectives On...

- Current challenges to voter trust and confidence, if any
- Future challenges, if any
- E2EV questions at the very end of interviews
  - Familiarity with the concept
  - Briefly describe in their own words
  - Impacts to voter trust and confidence, if any; benefits and challenges
- Tailored follow-up questions throughout interviews

Participant Demographics

- 4 sets of interviews
  - 8 Accessibility Experts
  - 9 Cybersecurity Experts
  - 7 Usability Experts
  - 9 General Election Experts (including former election officials)
- Total of 33 election experts participated in 32 interviews across the four expert groups
- Range of 10 to 40+ years elections experience, average of 23.46 years (SD = 8.14 years)
- Over 650 years of combined election experience
- Range of backgrounds, e.g., academia, industry, government, non-profits, election organizations, and standards organizations

Data Protections

- Participant data has been de-identified by assigning a participant code (e.g., A1, C1, U1, G1)
- As stated in our human subjects research approval, the research team will NOT make any attempts to reidentify study participants or link anonymized data back to specific individuals
- In order to maintain participant anonymity, experts are asked to neither self-identify as a participant nor discuss their participation in the study

The National Institute of Standards and Technology Research Protections Office reviewed the protocol for this research project (ITL-2023-06730) and determined it meets the criteria for "exempt human subjects research" as defined in 15 CFR 27, the Common Rule for the Protection of Human Subjects. Participants provided informed consent to be interviewed and recorded.

Defining E2EV: From the Literature

- **Cast As Intended**: voters make their selections and, at the time of vote casting, can get convincing evidence that their encrypted votes accurately reflect their choices;
- **Recorded As Cast**: voters or their designees can check that their encrypted votes have been correctly included, by finding exactly the encrypted value they cast on a public list of encrypted cast votes; and
- **Tallied As Recorded**: any member of the public can check that all the published encrypted votes are correctly included in the tally, without knowing how any individual voted.

Benaloh, J., Rivest, R., Ryan,P. Y. A., Stark, P., Teague, V., Vora, P., (2014) "End-to-End Verifiability." https://doi.org/10.48550/arXiv.1504.03778

Results: E2EV Findings

Views from Experts

E2EV: Not Top of Mind for Most Participants

- Many of the participants discussed E2EV only when prompted at the end of the interviews
- E2EV mentioned organically in 11 of 32 interviews; 6 of those were cybersecurity experts

Uncertainty When Defining E2EV

- Many experts expressed uncertainty when describing E2EV
  - Accessibility experts, usability experts, and general election experts

"I'm never quite sure of [E2EV verification]. But in general, that's my understanding." (A1)

"There's a ton of complexity underneath the hood." (G9)

- No uncertainty expressed by cybersecurity experts

Potential Impacts of E2EV: Differing Perspectives

- Experts held differing perspectives on benefits and limitations of E2EV in relation to voter trust and confidence in elections
  - Divide was not always consistent across expert groups

"Instead of telling voters that they should trust the results, 'There are good people doing it, don't worry,' **we should be giving voters direct evidence** so that they can **see for themselves** that their votes are being accurately counted." (C3)

vs.

"I no longer think that we'll have a truly fully end-to-end verifiable voting system where voters can independently verify the entire path. I don't think it's doable at scale. And by at scale, I mean scaling to the breadth of knowledge of individual voters. **I think they're too confusing for most voters**." (C6)

Potential Impacts of E2EV: Expert Views

Experts' overall sentiments towards the potential of E2EV to influence voter trust and confidence

	Accessibility Experts	**Cybersecurity Experts**	**General Election Experts**	**Usability Experts**	**Total** ***(n=27)***
Largely positive	1	3	2	1	**7**
Largely negative	2	2	2	6	**12**
Noncommittal	3	4	1	0	**8**

Potential Impacts of E2EV: Key Findings

- Experts voiced pros and cons of E2EV in four main areas

Support for evidence-based elections

Concerns about complexities of E2EV

The need to support modern and accessible voting technologies

Overall value proposition of implementing E2EV technology

Support for Evidence-Based Elections

Support for Evidence-Based Elections

- Some experts believed that E2EV has the potential to engender voter trust and confidence by providing evidence that election outcomes are accurate
- However, other experts believed that getting voters to take the extra verification steps may be difficult

> "The mental model that most people have of how to vote is: you make your selections and submit them, and that's the end of the game, right? So E2E systems, in order for them to actually do what they want to be doing, require at least some number of the voters to perform extra actions, right, to do verifications and to do whatever. And I think **it's always a challenge to motivate voters to perform those extra steps**." (U5)

Support for Evidence-Based Elections

- Some experts noted that E2EV systems have limitations if an issue is detected

"The verifiable technologies that we have are **all about detection of anomalies**. They're not about prevention. They're not about even recovery." (C3)

"If you discover that something went wrong… what you get is that, oh, the system doesn't actually verify the correct count. And so **it's got a large potential for a relatively small error to appear that the election has been completely compromised. And that actually has the potential to make things worse rather than better.** That could unnecessarily decrease confidence in what may be moderately flawed but still fundamentally sound election procedures." (C4)

Complexity of E2EV

Complexity of E2EV: Challenges Understanding

- Experts believed that E2EV introduces another layer of complexity to elections and may be difficult for voters and election officials to understand

"[E2EV systems] leave the voter with a receipt. And they are generally very clever to prevent that receipt from actually revealing to a third party how someone voted, [but] **they could create the impression among voters that their vote isn't secret anymore.**" (C4)

"People don't understand hash values. And so all of a sudden, I'm getting a string of codes. It's like, '**This isn't what I wanted. What I wanted was to see my ballot in the ballot box**.' 'Well, no, we can't do that because of X, Y, and Z ballot secrecy and so on and so forth." (G4)

Complexity of E2EV: Challenges Communicating

- Experts emphasized the need for effective communication and education about E2EV

"Communicating kind of how the process works from end-to-end…and breaking down the technology behind it, I think, is **where the real challenge lies**." (C9)

"Explaining the math behind the cryptography in [E2EV] is not worth the time for most people. But explaining... here's how we know your vote was counted as cast... That is worth the explanation. **I don't need to give you the equations, but I do need to walk you through more than just, 'Trust us. It's in there**.'" (G5)

Modern and Accessible Voting Technologies

Modern and Accessible Voting Technologies

- Some experts believed that E2EV could enable the introduction of more modern and accessible voting technologies

"I feel like we can make voting **more exciting and accessible** really easily with end-to-end verifiability." (C1)

"Maybe we can embrace some better technologies if we really got serious about end-to-end verification… I think if we use it as **an opportunity to make people feel more secure about newer technologies**, then it could have huge benefits for everyone." (A3)

Modern and Accessible Voting Technologies

- Many experts believed that current E2EV systems are often not fully accessible

"I have not seen a demonstration of an end-to-end verifiable system that is accessible… **They haven't figured that out** to my knowledge." (U4)

"I feel like anybody who cares about accessibility and true independence has to explore non-paper-based methods to really enable that for meaningful segments of the population. I think that's the thing that I feel is truly missing in this discussion. **It tends to focus on security, not access**." (C1)

Overall Value Proposition of E2EV

Overall Value Proposition

- Experts believed that it may be difficult to show the purpose and benefits of E2EV
  - What problem is E2EV solving?
  - Voter POV
  - Election official POV

"[E2EV is] a solution in search of a problem." (C2)

Overall Value Proposition

- Experts believed that it may be difficult to show purpose and benefits of E2EV
  - What problem is E2EV solving?
  - Voter POV
  - Election official POV

"I think putting end-to-end verification on top of already existing systems makes computer scientists feel better. And that's it. I don't think it even makes regular voters feel better because they don't know what it is. And **they've never thought about it, and I don't think they care**." (A3)

"If you look at surveys, **most people believe that their votes were counted accurately**. That is not the issue about where their doubts are coming from… It was that other people were able to vote and their votes shouldn't have been counted, or there were lots of extra votes that were added. That is the kind of thing where there seems to be confidence issues." (U2)

Overall Value Proposition

- Experts believed that it may be difficult to show purpose and benefits of E2EV
  - What problem is E2EV solving?
  - Voter POV
  - Election official POV

"If election officials can't understand it and explain it, they're not going to use it because they know that **if they introduce something new that they can't explain, they're inviting criticism and conspiracy**, right?... [Election officials] ask me all the time, '...Am I introducing more problems, or are you solving a problem for me?' And I think it's solving a problem for them from a trust, transparency and validation point of view. But **if they don't believe that they can explain that, it's going to do them no good**." (G5)

Overall Value Proposition

- Some experts mentioned the successes of real-world E2EV implementations
  - Takoma Park, Maryland's Municipal Election, 2009
  - Fulton, Wisconsin's Municipal Election, 2020
  - Franklin County, Idaho's General Election, 2022
  - College Park, Maryland's Municipal Election, 2023

- Some experts believed that, if E2EV is more widely-implemented, people may come to trust and value it

"How many times have you gotten on an airplane? And did you understand what it takes to make an airplane safe? And, of course, very few of us do…Well, so why did you do it? Well, you had experts that you believed in, or friends that believed in experts, or experience over time." (C8)

Overall Value Proposition

- Many experts believed that E2EV is not the panacea for increasing voter trust and confidence

"[E2EV is] not going to be a silver bullet." (C7)

"I'm not opposed to it. I'm not against it. I think adding layers of defense, providing people opportunities to be able to build that trust is a good thing, but **it is definitely not the panacea**." (G4)

"It's hard for me to believe that there's a **magic technology** that's going to suddenly make everybody go, 'Oh, I've seen the error of my ways. Our elections are great.'" (U1)

Summary of E2EV Findings

Implications of E2EV for Voter Trust and Confidence

- Experts' perceptions of E2EV influence on voter trust and confidence
  - Benefits: Potential to increase voter trust and confidence
  - Concerns: Potential to decrease voter trust and confidence by introducing additional complexities that could then be misunderstood or even intentionally exploited in the information environment

- Experts' perceptions of E2EV technology
  - Benefits: Offers important properties for election integrity
  - Concerns: Requires a shift in voters' mental models – to include a verification step – for one of the important properties of E2EV to be fully realized

Wrapping up E2EV Findings

- E2EV technology is intended to improve voter trust and confidence
- EAC-NIST-NCCoE E2EV workshop was the original motivator for this research study
  - Panelists indicated that widespread adoption of E2EV may not be solely dependent on technical protocols, requirements, and evaluation criteria of E2EV
  - Election officials expressed concern over largescale sweeping changes and preferred incremental change
  - Panelists also noted that E2EV technologies have not been fully accessible for voters with disabilities
- Our data suggests that there are more pressing issues facing election officials today than those specific technological challenges that E2EV could potentially address

"The biggest challenge is [that E2EV is] this **beautiful technical solution** to something that I'm not sure is perceived by society as the biggest shortcoming or the biggest challenge with elections right now." (C2)


Summary of Study Findings: Expert Views
Challenges
Election experts described four overarching challenges influencing voter trust and confidence.
Limited or incorrect voter knowledge and understanding about elections.
Need for technology that is usable, accessible, and secure.
Unrealistic or unmet voter expectations about elections.
Insufficient resources for Election Officials.
Current and Potential Improvements
Election experts described four potential ways to address some of these challenges.
Technologies to increase voter trust and confidence.
Enhanced voter communication and education related to elections.
Greater recognition and support for the Election Official profession.
Increased resources for Election Officials.
Complexity of Technology and Election Processes
Information Environment Surrounding Elections
Election Officials
Election Officials face multiple challenges as they work to facilitate elections.
Election Officials are the connective tissue between elections and voter trust and confidence.
Election Officials need help to implement current and future improvements.
Voter Trust and Confidence
Influenced by external factors such as the complexity of elections and the information environment. External factors permeate the world of voters but are largely outside the control of Election Officials.
Influenced by a variety of challenges, some of which can be addressed by Election Officials through advancements and improvements.

The Golden Triad

- Must consider the Golden Triad: **people**, **process**, and **technology**
- Election technology, including E2EV, should not be developed in a vacuum
- Care and caution needed especially when substantial changes add complexity and are difficult for voters to understand

"We probably have to weigh [technological improvements] against whether that's going to degrade confidence." (C4)

"Getting the technology right is important, but… second in importance to… the institutions of trust and the perception and designing systems that people can understand and feel confident in." (C2)

“You can’t create voter confidence with math.”

(C7)

Thank you

Kristen.Greene@nist.gov

Shanee.Dawkins@nist.gov

vote.nist.gov

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Extra Slides

Risk Limiting Audits (RLAs)

- Experts emphasized the importance of auditing procedures and the need for widespread adherence to best practices

"I think there are opportunities to reduce the cost of audits and make them more efficient. The equipment can help support, for instance, ballot level auditing rather than batch level auditing. And I think that would make audits take less time from election officials and cost less money... it might enable better auditing that right now is too burdensome for election officials." (C2)

"thinking about auditing and how to make that auditing usable for election officials, all of that helps with trust and confidence in terms of good design and user interaction. And those are not trivial problems." (U6)