

## Scantegrity Mock Election at Takoma Park (summary)

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**Abstract.** We report on our experiences and lessons learned using the Scantegrity II voting and audit system in a mock election held April 11, 2009, in Takoma Park Maryland with ninety-five voters.

**1. Introduction.** On April 11, 2009, ninety-five voters cast ballots with the Scantegrity II voting system during a mock election held at the Community Center in Takoma Park, Maryland, coinciding with Takoma Park’s celebration of Arbor Day. The purpose of this exercise, which we call *Mock1*, was to demonstrate Scantegrity II’s readiness for the Takoma Park municipal election in November 2009, in which voters will cast ballots for mayor and ward council members. The November election will mark the first time any *end-to-end (E2E)* cryptographic voting system will be used in a binding governmental election.<sup>2</sup> This overview summarizes our experiences using Scantegrity II (henceforth referred to as “Scantegrity”). We present and interpret data collected through questionnaires, unobtrusive observations, and focus groups. For more details, see our full paper [She09] and website [Scan], which includes detailed supporting items (*e.g.*, questionnaires, agreement with City, human subjects review documents).

Scantegrity [Cha09, Cha08b, Cha08a] is a software-independent cryptographic audit system that augments a traditional optical-scan voting process. In *Mock1*, voters marked paper ballots with special pens that contained a revealing ink, exposing a randomly chosen codenumber in each marked oval, which the voter could write down on a detachable ballot chit. After polls closed, each voter had the option of checking her codenumbers on-line, to verify that her vote had been recorded as intended. Furthermore, Scantegrity is *universally verifiable*: anyone could verify on-line, using special software of his or her choice, that the tally was computed correctly from the official data. We tested Scantegrity because it shows promise for widespread adoption: the verification steps are optional and the voting experience is similar to that of traditional optical scan.

Many have criticized E2E systems as being difficult to understand, use, and administer—yet there is little evidence to support or contradict this belief. *Mock1* is part of a larger research project to measure how easy it is for voters to vote with Scantegrity, how easy it is for poll workers to administer Scantegrity, and how well voters and poll workers accept this revolutionary system. As a capabilities demonstration, *Mock1* tested only the Scantegrity voting system and closely followed voting and verification procedures that will be used in November’s binding election. In the binding election will we will survey voters and measure the impact of Scantegrity on poll workers. In April 2010, we plan to carry out *Mock2*, a controlled comparative field test and expert review comparing Scantegrity with a commercial optical scan voting system. Although the binding election and hence *Mock1* constrain research methodologies, only through a binding election can one adequately measure the impact of Scantegrity on poll workers.

**2. Methods.** At *Mock1* we measured Scantegrity’s performance through surveys, observations, and focus groups. To prevent well-known chain-voting attacks, ballots were locked onto clipboards (see Figure 1). Eighty voters and six of the seven Takoma Park poll workers filled out questionnaires about their experiences with Scantegrity, including questions about how easy the system was to use and administer and how well they understood and accepted the system. In the polling room, two unobtrusive observers watched and timed fifty-three of the voters as they voted, filling out voter observation sheets. As voters

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<sup>2</sup> RIES was used twice in 2004 in the Netherlands in a government Internet election, but this voter- and universally-verifiable system offers no security against vote selling.

left the polling room, they were invited to fill out a survey. A professional moderator led two focus groups: one for poll workers, and one attended by four voters. After polls closed, 29 (31%) of the voters verified their votes on-line, using a privacy-preserving receipt on which each voter copied codenumbers exposed during the voting process for their ballot choices. This receipt does not reveal the ballot choices. Seven of these voters also filled out additional on-line questionnaires about the verification process.

To avoid possible confusion, Takoma Park officials required that races on our Mock1 ballot not resemble those on official ballots. Figure 2 shows the Mock1 ballot, which featured four questions about trees. By contrast, Mock2 will test two systems using realistic state ballots.

Any consenting adult who wanted to vote was permitted to do so. We advertised the event through email, web pages, local TV, and in the *Takoma Park Newsletter*. As each voter left the polling room, a researcher asked the voter if she would be willing to fill out a questionnaire. Twelve voters agreed to participate in a focus group later in the day, of whom four returned.

**3. Results.** Although the self-selected voters were not representative of the Takoma Park voting population, they provided useful feedback. Our mock voters had high family incomes, were highly educated, frequently used computers, were mostly 50–64 years old. Six Takoma Park poll workers participated in the poll worker focus group. Each was experienced and had worked previous elections in Takoma Park. None of poll workers, and none of the people participating in surveys or focus groups, were part of the Scantegrity Team.

Because both groups expressed similar thoughts without notable disagreements, we summarize the main comments from both groups together, as reported by the moderator: (1) The voting process took too much time. (2) Providing instructions in one chunk at the beginning was overwhelming. (3) The instructions were too complex, and there was too much explanation. (4) Although the voters in the focus group did not experience difficulties voting, some wondered if other voters in Takoma Park might experience difficulties writing down codenumbers and verifying their votes on-line. (5) Vote casting at the scanning table took too much time. (6) Poll workers disliked that a Scantegrity team member handled the ballot during scanning. (7) The scanner was finicky. (8) During scanning, the poll workers liked the feedback of seeing light on a flash drive blink, suggesting that the ballot was read. (9) The locked clipboard added time and complexity but did not seem to significantly increase security. (10) The special pens should be available only in the voting area. (11) Poll workers felt that they should have been more in charge, especially of the flow of voters around the room. (12) Poll workers felt that the process could be sped up to make it viable for the binding election.

**4. Discussion.** The main two issues were that the process was too slow (taking about eight minutes to vote on average) and many voters found the instructions complicated. Much of the delay was caused by the scanning process and lengthy instructions given to voters. Fortunately, these problems are solvable through process simplification and improvement, better and multiple scanners, and careful human-factors testing. Some Mock1 voters were enthusiastic about the security features of Scantegrity, but most seemed not to care much about security, focusing primarily on the physical process of receiving a ballot, marking the ballot, and scanning the ballot.

Recommendations from the poll workers and our team include: (1) Eliminate the locked clipboard. (2) Eliminate redundant instructions. Do not provide instructions for optional steps at beginning of process; provide them when voters select an optional step and in pre-election documentation. (3) Print codenumbers with a reduced character set to avoid easily confused letters. (4) Use “chisel” style special pens for ease of marking ovals. (5) Consider adding a printer to print the confirmation codes. (6) Have multiple scanners to increase voter throughput.

The mock election provided preliminary evidence that Scantegrity can be effectively used in elections and will likely be well accepted by voters, though the flow of people through the voting process must be greatly improved. In separate projects, our team is seeking better solutions for the vital challenge of making high-integrity voting truly accessible to differently-abled voters, including the blind.

## References

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- [Cha08b] Chaum, David, Aleks Essex, Richard Carback, Stefan Popoveniuc, Jeremy Clark, Peter Ryan, Alan T. Sherman, Ronald Rivest, and Poori Vora, "Scantegrity II: Voter-Verifiable Optical Scan Ballots with Invisible Ink Confirmation Codes," in on-line *Proceedings of USENIX/ACCURATE EVT 2008* (April 2008), [http://www.usenix.org/events/evt08/tech/full\\_papers/chaum/chaum.pdf](http://www.usenix.org/events/evt08/tech/full_papers/chaum/chaum.pdf).
- [Cha09] Chaum, David, Richard Carback, Jeremy Clark, Aleksander Essex, Stefan Popoveniuc, Ronald L. Rivest, Peter Y.A. Ryan, Emily Shen, Alan T. Sherman, and Poorvi Vora, "Scantegrity II: End-to-End Verifiability for Optical Scan Elections," submitted to *IEEE Transaction on Information, Forensics, and Security* - special issue on voting (February 22, 2009), in review.
- [Scan] [www.scantegrity.org](http://www.scantegrity.org)
- [She09] Alan T. Sherman, Richard Carback, David Chaum, Jeremy Clark, Aleksander Essex, Paul S. Herrnson, Travis Mayberry, Stefan Popoveniuc, Ronald L. Rivest, Emily Shen, Bimal Sinha, Poorvi Vora, "Scantegrity Mock Election at Takoma Park," manuscript (April 17, 2009), 16 pages.

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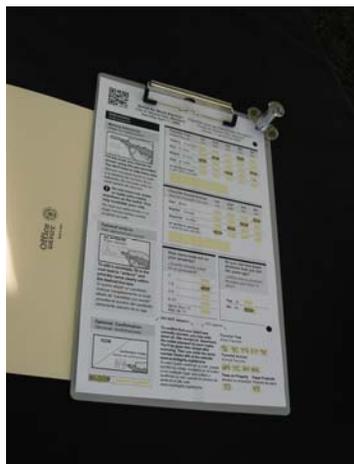


Figure 1: Locked clipboard resists chain voting.

Ballot for Mock Election  
City of Takoma Park, Maryland  
Saturday, April 11, 2009

Papeleta para las Elecciones Simuladas  
Ciudad de Takoma Park, Maryland  
Sábado, 11 de Abril de 2009

Favorite Tree Árbol Favorito	1st 1 ra	2nd 2da	3rd 3ra	4th 4ta
Cherry el cerezo	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Elm el olmo	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maple el arce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Oak el roble	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
or write-in tree o por árbol escrito:	<input type="text"/>			

Favorite Forest Animal Animal Arbolado Favorito	1st 1 ra	2nd 2da	3rd 3ra
Owl Búho	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rabbit Conejo	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Squirrel Ardiá	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
or write-in animal o animal por escrito:	<input type="text"/>		

How many trees are on your property?  
¿Cuánto árboles están en su propiedad?

0

1-2

3-5

5-10

More than 10  
Más de 10

Do you use less paper products than you did ten years ago?  
¿Utiliza menos producto de papel que hace 10 años?

Yes Sí

No No

Confirmation Codes  
Números de confirmación

Favorite Tree  
Árbol Favorito:

Favorite Forest Animal  
Animal Arbolado Favorito:

Trees on Property  
Árboles en propiedad:

Paper Products  
Productos de papel:

Figure 2: Ballot (shown smaller than actual size).