Vote by mail

Design and verification of a secure protocol

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Motivations

Why be interested in postal voting?

Medium stakes ballots

Remote voting is widely used:

- Professional elections
- Trade union elections
- Associations
- University boards of directors
- Political primaries

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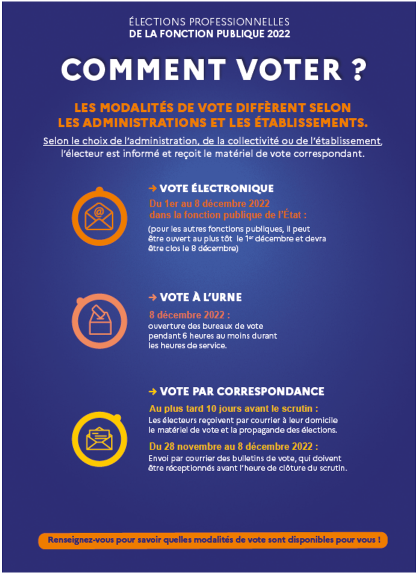


ÉLECTIONS PROFESSIONNELLES
DE LA FONCTION PUBLIQUE 2022

COMMENT VOTER ?

LES MODALITÉS DE VOTE DIFFÈRENT SELON LES ADMINISTRATIONS ET LES ÉTABLISSEMENTS.

Selon le choix de l'administration, de la collectivité ou de l'établissement, l'électeur est informé et reçoit le matériel de vote correspondant.

→ **VOTE ÉLECTRONIQUE**

Du 1er au 8 décembre 2022 dans la fonction publique de l'État :

(pour les autres fonctions publiques, il peut être ouvert au plus tôt le 1er décembre et devra être clos le 8 décembre)

→ **VOTE À L'URNE**

8 décembre 2022 :

ouverture des bureaux de vote pendant 6 heures au moins durant les heures de service.

→ **VOTE PAR CORRESPONDANCE**

Au plus tard 10 jours avant le scrutin :

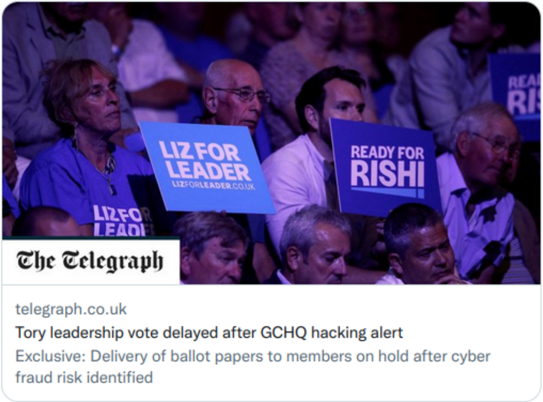
Les électeurs reçoivent par courrier à leur domicile le matériel de vote et la propagande des élections.

Du 28 novembre au 8 décembre 2022 :

Envoi par courrier des bulletins de vote, qui doivent être réceptionnés avant l'heure de clôture du scrutin.

Renseignez-vous pour savoir quelles modalités de vote sont disponibles pour vous !

… but also very high stakes



telegraph.co.uk

Tory leadership vote delayed after GCHQ hacking alert

Exclusive: Delivery of ballot papers to members on hold after cyber fraud risk identified

2022 Conservative Party leadership election

Objectives

- Voters must be able to vote without a computer. It may be required to conduct verifications.
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Some properties measure the quality of a protocol.

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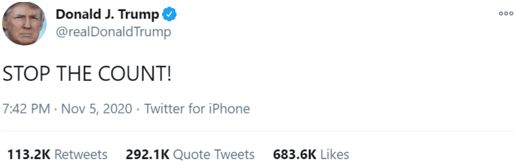


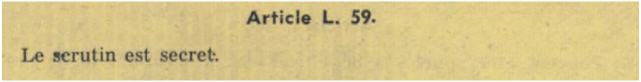
Donald J. Trump
@realDonaldTrump

STOP THE COUNT!

7:42 PM · Nov 5, 2020 · Twitter for iPhone

113.2K Retweets **292.1K** Quote Tweets **683.6K** Likes

Privacy



Article L. 59.

Le scrutin est secret.

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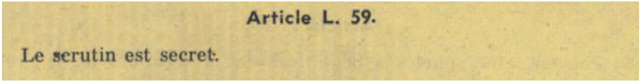
Privacy



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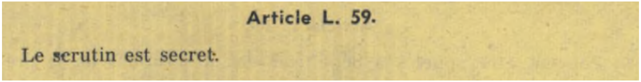

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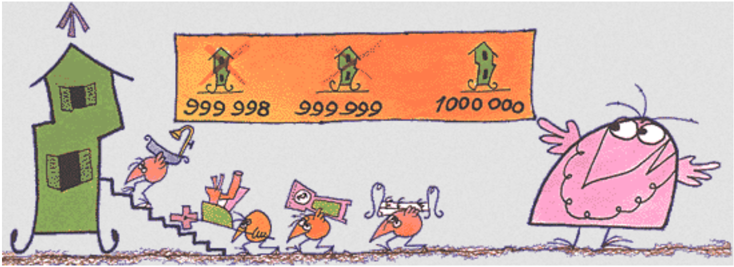
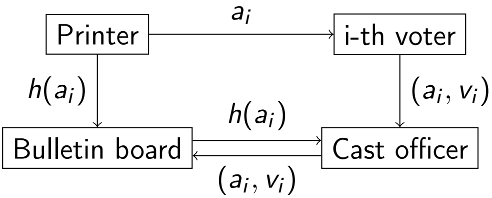
- **Accountability:** In case of problems, it is possible:
  - for the witness to support their denunciation.
  - for each entity to prove that it has followed the protocol.

Design of a protocol



Trial and error

First attempt



Idea: each voter receives a token a_i to track their ballot.

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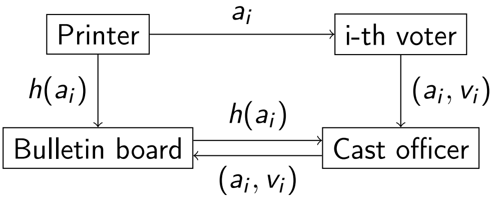

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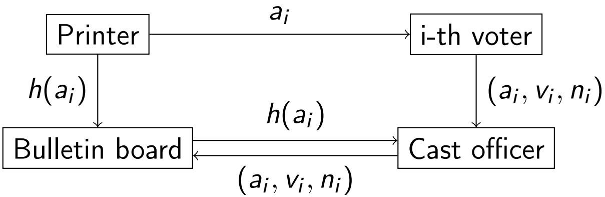
Clash attack

A dishonest printer may send the same token to different voters.

First contermeasure



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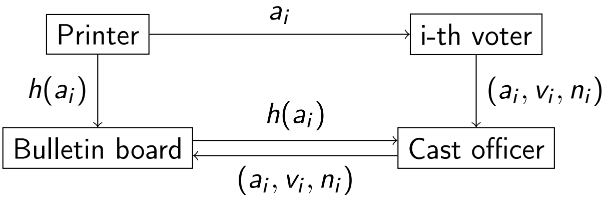

Printer

a_i

i-th voter

$h(a_i)$

(a_i, v_i, n_i)

$h(a_i)$

Bulletin board

Cast officer

(a_i, v_i, n_i)

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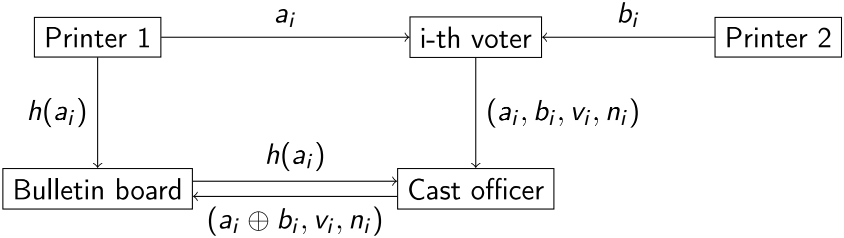
Honest but curious attacker

The printer knows everyone's vote.

Second contermeasure



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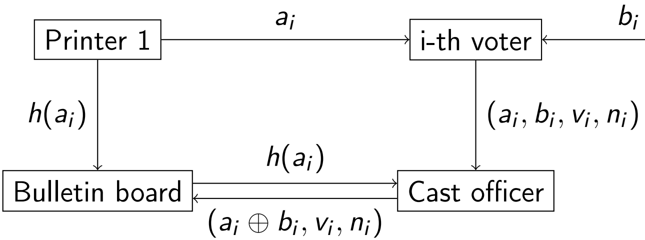

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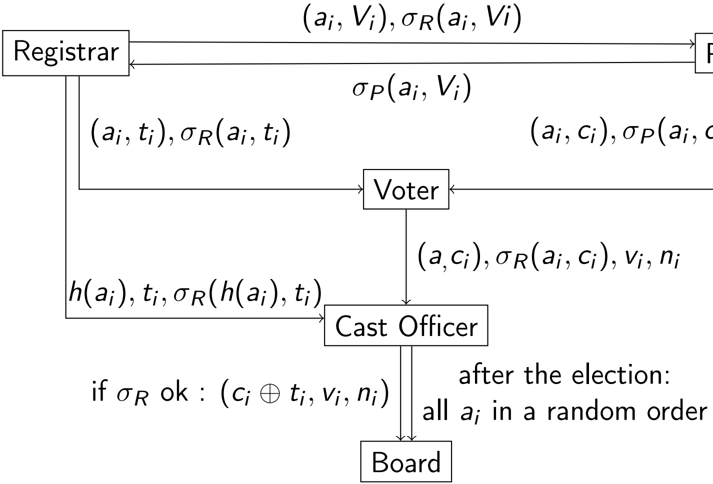
Complexity of the protocol

Each voter receives two envelopes.

Vote&Check


$(a_i, V_i), \sigma_R(a_i, Vi)$
Registrar
Printer
$\sigma_P(a_i, V_i)$
$(a_i, t_i), \sigma_R(a_i, t_i)$
$(a_i, c_i), \sigma_P(a_i, c_i)$
Voter
$(a_, c_i), \sigma_R(a_i, c_i), v_i, n_i$
$h(a_i), t_i, \sigma_R(h(a_i), t_i)$
Cast Officer
if σ_R ok : $(c_i \oplus t_i, v_i, n_i)$
after the election:
all a_i in a random order
Board

Security properties

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- Individual verifiability holds even if all the entities are dishonest.
- The eligibility holds if the registrar is honest or if the printer and the cast officer are honest.
- Universal verifiability always holds.

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Privacy

- The secrecy holds if the registrar and at least one of the two other entities are honest.
- The coercion resistance never holds.

Overview table

	Untrusted entities		
	At most 1	2 but not reg.	2 including reg.
Individual verifiability	✓	✓	✓
Universal verifiability	✓	✓	✓
Eligibility	✓	✓	✗
Ballot secrecy	✗	✗	✗
Coercion resistance	✗	✗	✗

Thanks for your attention