Electronic voting

Requirements for electronic voting

Fairness: no early results can be obtained which could influence the remaining voters.

Eligibility: only legitimate voters can vote, and only once (**Democracy**).

Privacy: the fact that a particular voted in a particular way is not revealed to anyone.

Individual verifiability: a voter can verify that her vote was really counted.

Universal verifiability: the published outcome really is the sum of all the votes.

Receipt-freeness: a voter cannot prove that she voted in a certain way.

Stages of election procedures

- **Registration** – In the registration stage the authorities determine who is eligible to vote, maintain proper lists of the registered voters;
- **Validation** –when the election begins, administrators validate the credentials of those attempting to vote.
- **Collection** – At this stage the voted ballots are collected before the final stage of the tally;
- **Tallying** – At this stage the accumulated votes are counted, agreed upon and published.

Participants (components) of e-vote systems

- **Voter:** Person who casts ballot.

- **Validator:** Person who authenticates the Voter.

- **Tallier:** Person who counts ballots and publishes results.

Simple voting protocol

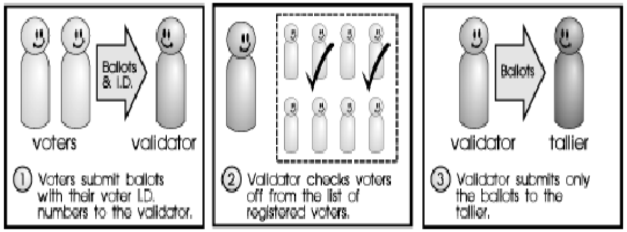
Registration: assign each eligible voter with a unique voter-id (VID).

Election: the voter submits an electronic ballot (B) with the voter identification number attached to the “Validator”.

Validation: the validator uses the identification number to check the voter off on a list of registered voters. Then the identification number is stripped off and the ballot is sent to an electronic “tallier”.

Tallying: The tallier records the votes and adds them to the election tally.

Simple voting protocol



① Voters submit ballots with their voter I.D. numbers to the validator.

② Validator checks voters off from the list of registered voters.

③ Validator submits only the ballots to the tallier.

Issues with the simple protocol

- Voters cannot be sure that the validator does not violate their privacy.
- There is no way to ensure that the validator does not alter ballots before sending them to the tallier;
- There is no way to ensure that the tallier accurately records the votes.

FOO protocol

Fujioka,Okamoto, and Ohta (1992):

Practical secret voting scheme based on blind signatures.

Notation:

b	the ballot.
e,d	the voter’s private and public encryption/decryption keys.
k	a random blinding value.
ev,dv	the validator’s public and private encryption/decryption keys.

FOO protocol. Preparation and Verification

Voter's Preparation

- A voter prepares a ballot **b**, encrypts it with a secret key **$b^e = B$**, and blinds it **($B * k^{ev}$).**
- The voter then **signs** the ballot **($B * k^{ev}$, id)** and sends it to the validator.

Verification:

- The validator verifies that the signature belongs to a registered voter who has not yet voted.
- If the ballot is valid, the validator signs the ballot - **$(B * k^{ev})^{dv}$** - and returns it to the voter.

FOO protocol. Collection

Collection:

- The voter removes the blinding encryption layer **$(B * k^{ev})^{dv} / k$**, revealing an encrypted ballot signed by the validator **B^{dv}**.
- The voter then sends the resultant signed-encrypted-ballot **B^{dv}** to the tallier.
- The tallier checks the signature on the encrypted ballot. If the ballot is valid, the tallier places it on a list that is published after all voters vote.

FOO protocol. Final stages.

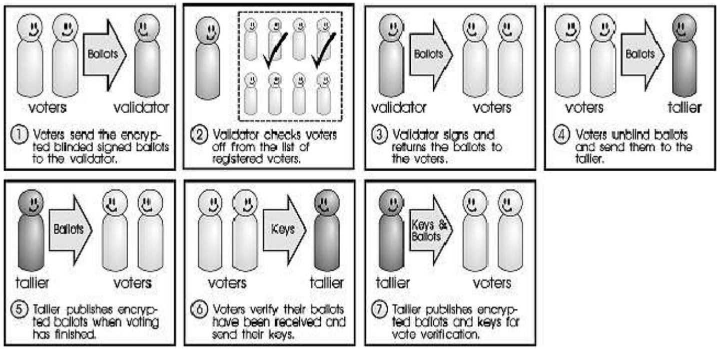
Tallying:

- After the list has been published, voters verify that their ballots are on the list and send the tallier the decryption keys (ballots are still encrypted at that moment!)
- The tallier uses these keys to decrypt the ballots and add the votes to the election tally.

Verification:

- After the election the tallier publishes the decryption keys along with the encrypted ballots so that voters may independently verify the election results **(B,b,d).**

FOO protocol



1 Voters send the encrypted blinded signed ballots to the validator.

2 Validator checks voters off from the list of registered voters.

3 Validator signs and returns the ballots to the voters.

4 Voters unblind ballots and send them to the tallier.

5 Tallier publishes encrypted ballots when voting has finished.

6 Voters verify their ballots have been received and send their keys.

7 Tallier publishes encrypted ballots and keys for vote verification.

Additional assumption

- For FOO to protect privacy one has to rely on the assumption that

signed unblind ballots and their keys are sent to the tallier over an an anonymous channel

Good properties of FOO

- **Privacy:** voters' anonymity from authorities is assured, even in the case when Validator and Tallier may cooperate;
- **Verifiability**: voters can verify ballots were counted correctly;
- **Flexibility**: FOO may be used for different formats of polls (simple "yes/no" format; multiple choice, etc).

Issues with FOO (and other protocols)

- The Validator can stuff the ballot box with abstaining votes;
- The protocol provides voters with the means to verify (and thus prove) their vote (no receipt-freeness) ;
- Anonymity allows voters to let someone else vote for them.

Although these problems may be remedied to some extent they still main obstacles in large scale practical applications such as general elections