Voting with coercion resistance and everlasting privacy using linkable ring signatures

Panagiotis Grontas, Aris Pagourtzis and Marianna Spyrakou

School of Electrical and Computer Engineering
National Technical University of Athens

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Ideal Properties of an Electronic Voting Scheme

- Verifiability
- Privacy
- Receipt freeness
- Coercion resistance

Overview

We propose a voting scheme that:

- provides **coercion resistance** ([JCJ05] framework)
- is based on **linkable ring signatures**
- provides **verifiability, ballot secrecy** and **everlasting privacy**

[JCJ05] Juels, Catalano, Jakobsson. Coercion-resistant electronic elections

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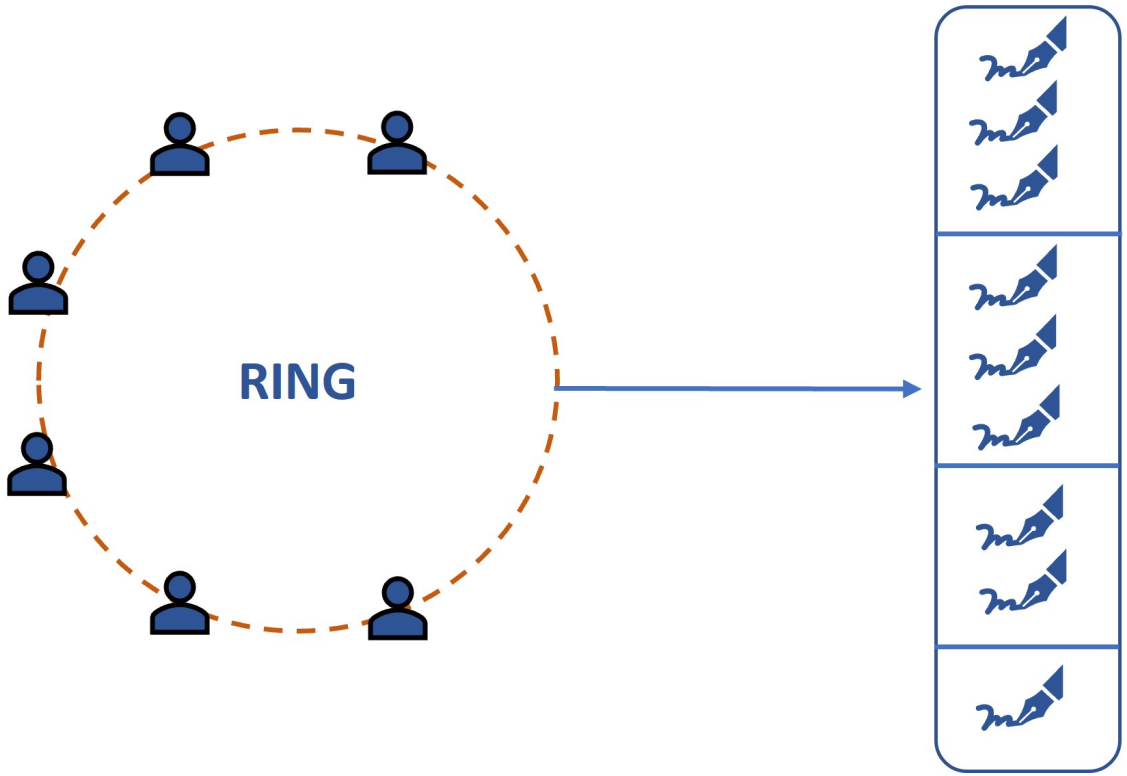
Linkable Ring Signatures



- Ring Signatures [RST01]
- Linkable Ring Signatures [LWW04]

[RST01] Rivest, Shamir, Tauman. How to Leak a Secret

[LWW04] Liu, Wei, Wong. Linkable Spontaneous Anonymous Group Signature for Ad Hoc Groups

Can we use linkable ring signatures in voting?

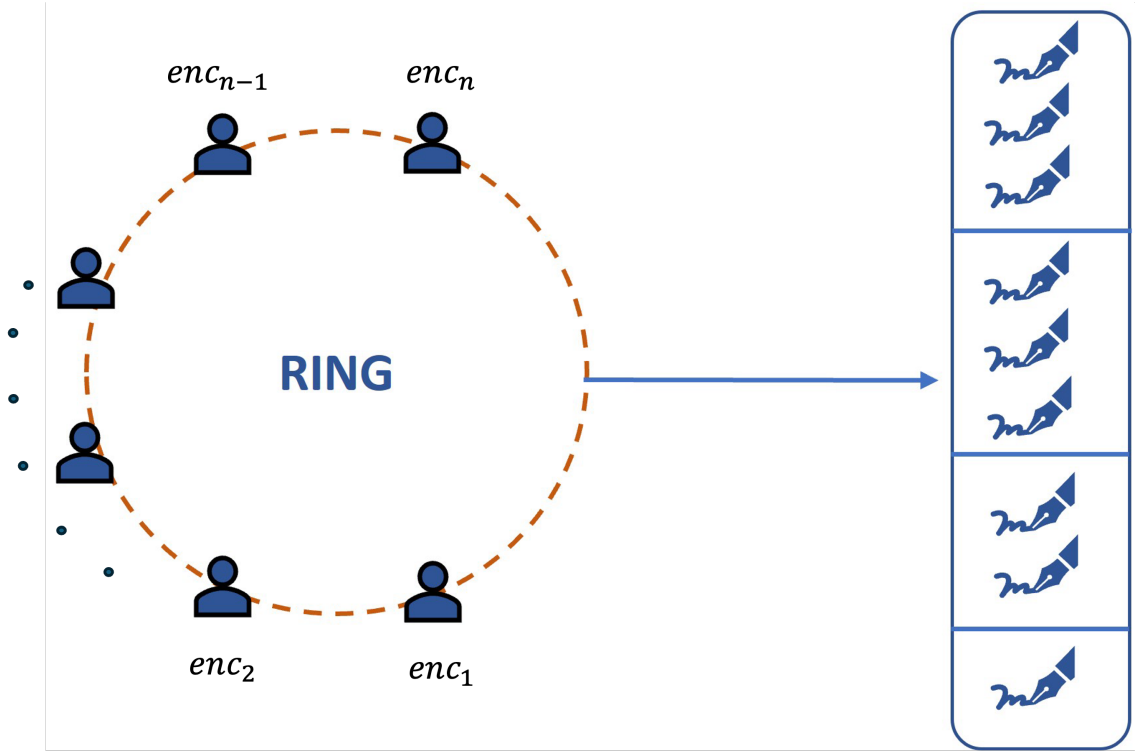
Properties achieved

- Verifiability
- Privacy
- Avoid double voting

Properties **not** achieved

- Receipt freeness
- Coercion resistance

Our LRS construction



- Signature scheme based on [LWW04], where the public credentials are encrypted values.
- Our signature is a proof of knowledge of the **secret credential** and of the **encryption randomness**.

LRS Signature

Properties

- **Unforgeability:** Noone besides the ring members is able to produce valid signatures.
- **Unconditional Anonymity:** Given a valid signature, noone can distinguish which ring member was the signer.
- **Linkability:** Two signatures from the same signer are linked.
- **Non-slanderability:** no one can create a valid signature that is linked with a given signature.

LRS Signature

Properties

- **Unforgeability** – Ensures verifiability
- **Unconditional Anonymity** – Achieves everlasting privacy
- **Linkability** – Avoids double voting
- **Non-slanderability** – Ensures that only the voter can update their vote.

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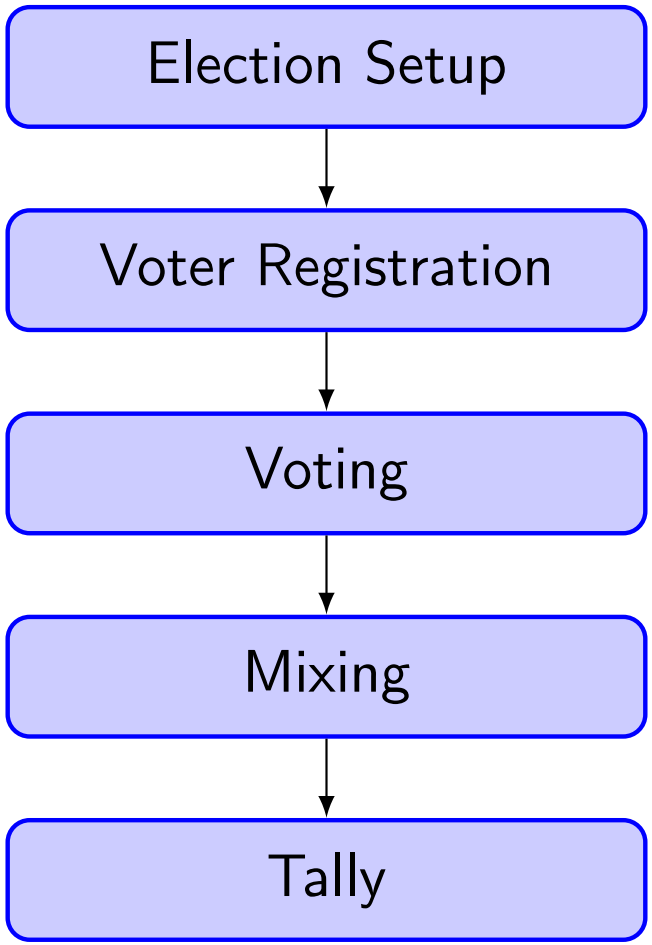
Overview



Participating entities

- System supervisor

  Runs the Election Setupand publishes the public parameters required for the voting procedure to take place.

- Registration Authority (RA)
- Tallying Authority (TA)
- Voters (V)
- Bulletin Board (BB)

  Authenticated append- only ledger that contains all public election data.

Voter Registration

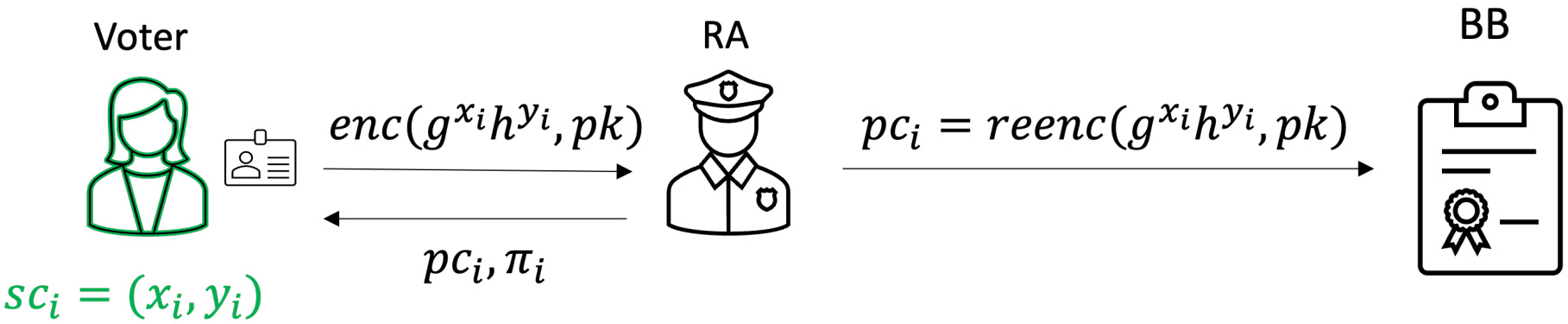


Figure 2: Registration Phase

After the registration phase

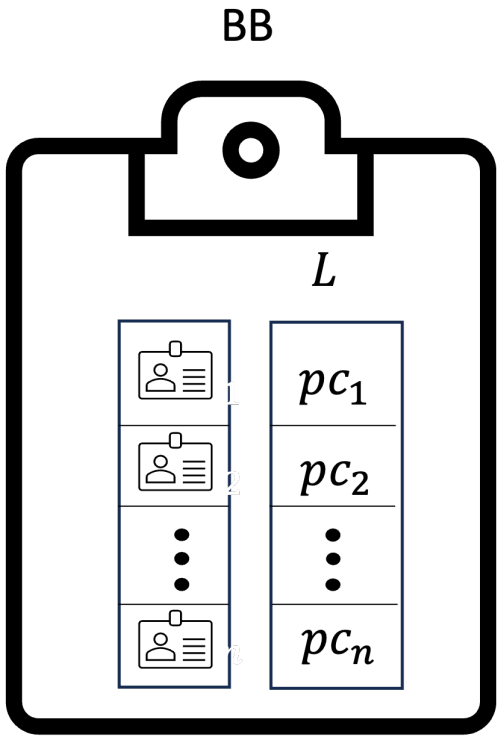


Figure 3: After the Registration phase the BB contains the list of eligible voters and a list L with their corresponding public credentials.

Voting

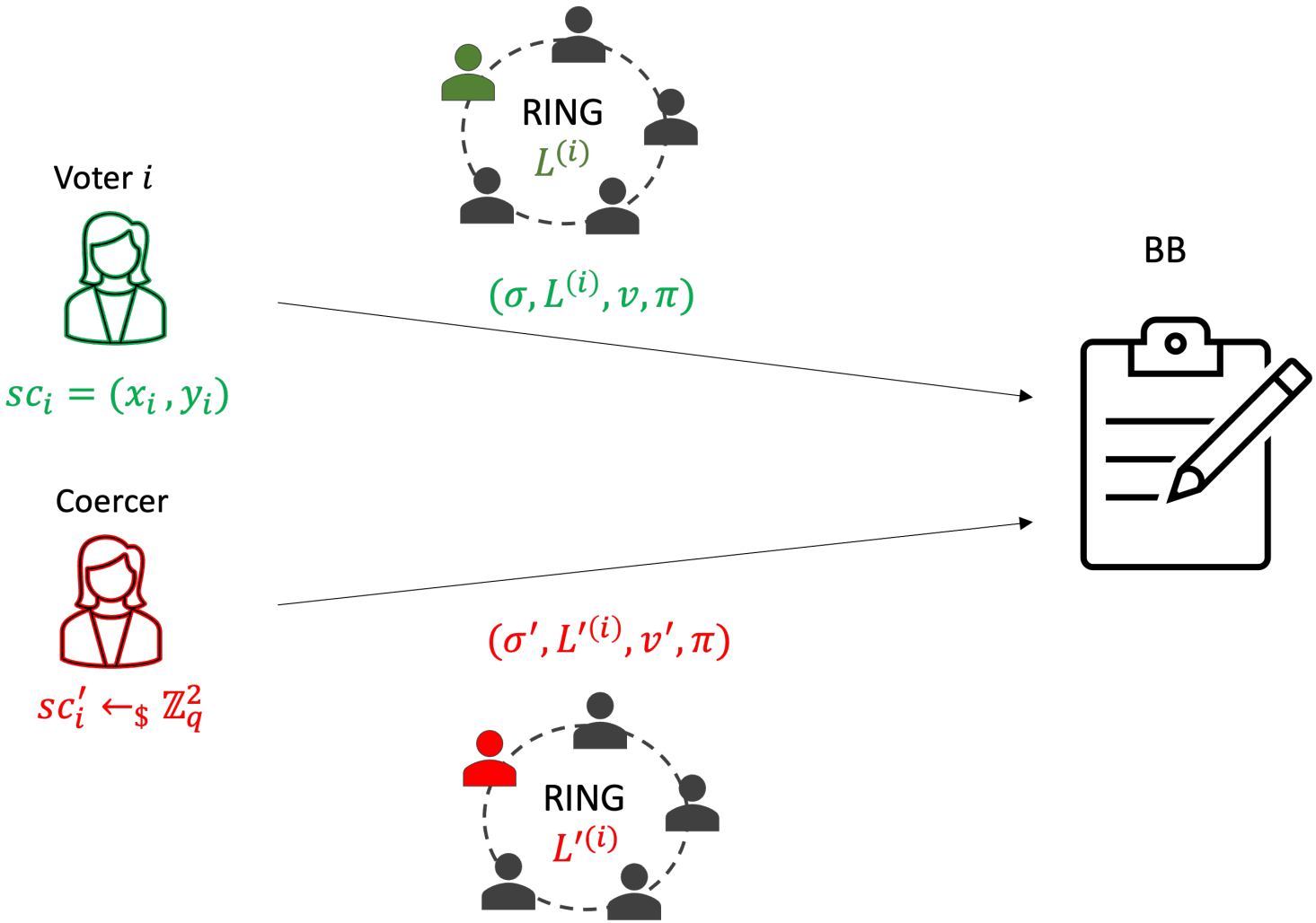


Figure 4: Voting Phase

Mixing

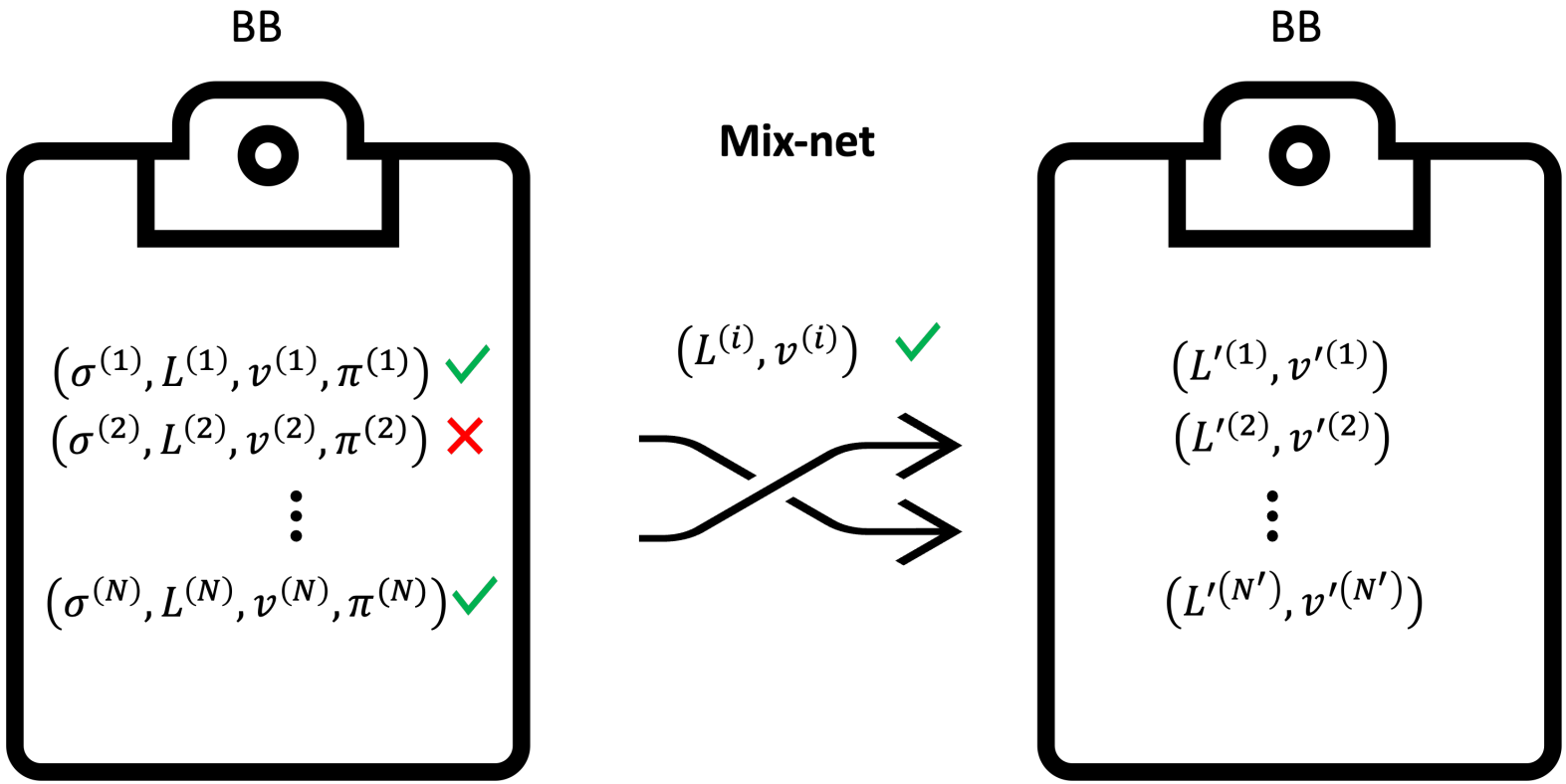


Figure 5: Mixing Phase

Tally

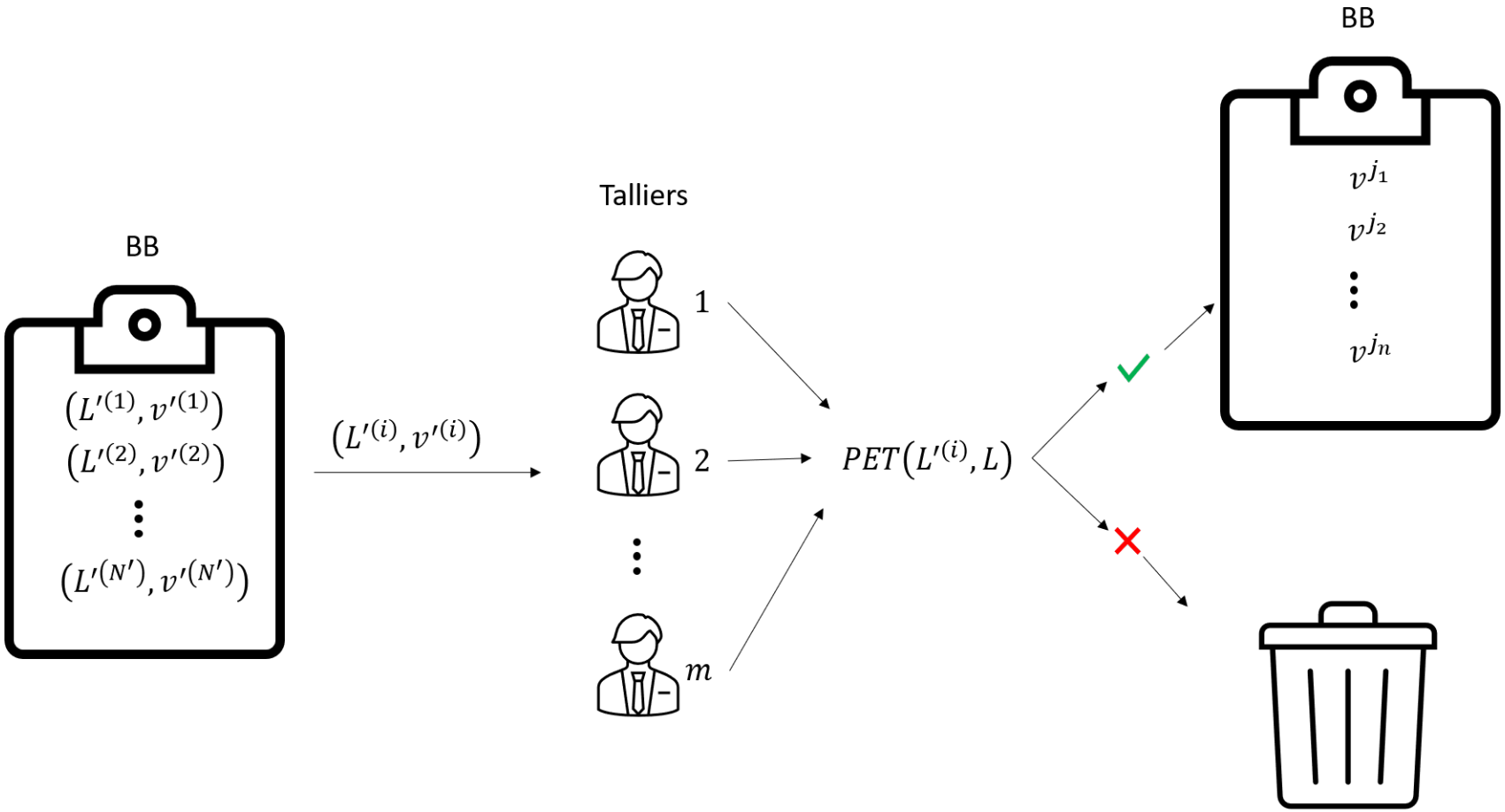


Figure 6: Tally

Security Properties

Individual & Universal **Verifiability**: Are achieved by the NIZK proofs provided by the voters, the registration and tallying authorities.

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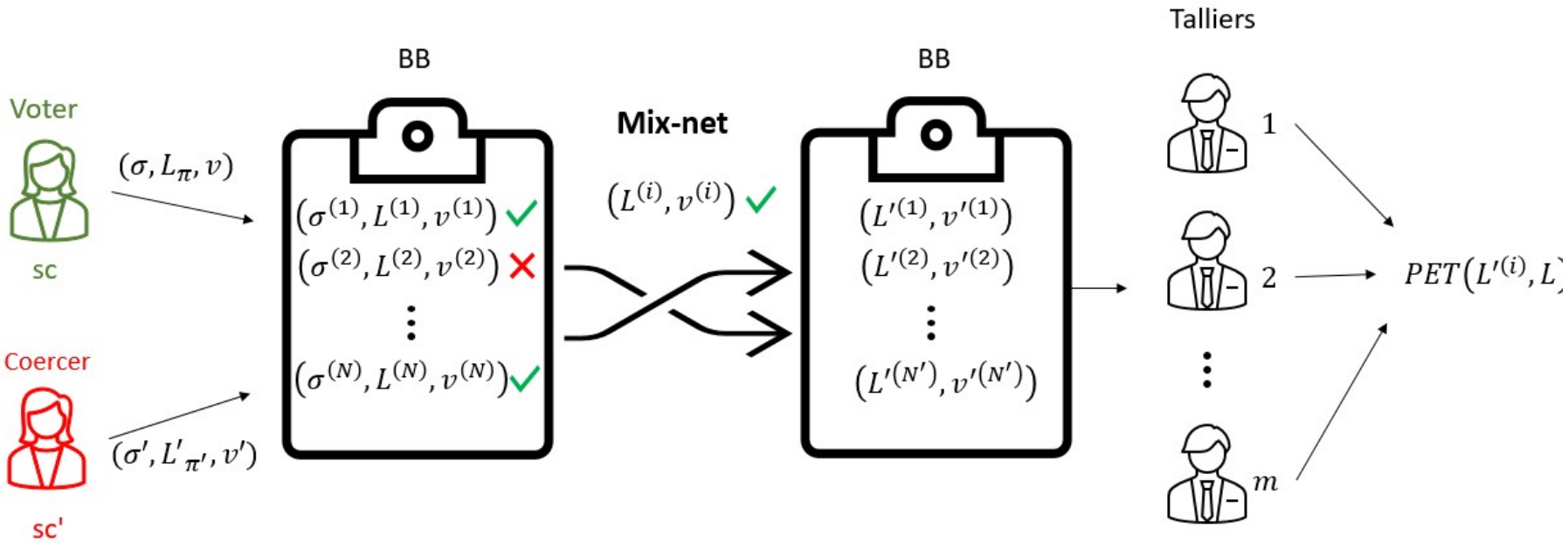
Everlasting Privacy:
is achieved by the unconditional anonymity property of our LRS.


Voter
sc
Coercer
sc'
(σ, L_π, v)
$(\sigma', L'_{\pi'}, v')$
BB
$(\sigma^{(1)}, L^{(1)}, v^{(1)})$
$(\sigma^{(2)}, L^{(2)}, v^{(2)})$
$(\sigma^{(N)}, L^{(N)}, v^{(N)})$
Mix-net
$(L^{(i)}, v^{(i)})$
BB
$(L'^{(1)}, v'^{(1)})$
$(L'^{(2)}, v'^{(2)})$
$(L'^{(N')}, v'^{(N')})$
Talliers
1
2
m
$PET(L'^{(i)}, L$


Thank you!