CERIAS

The Center for Education and Research in Information Assurance and Security

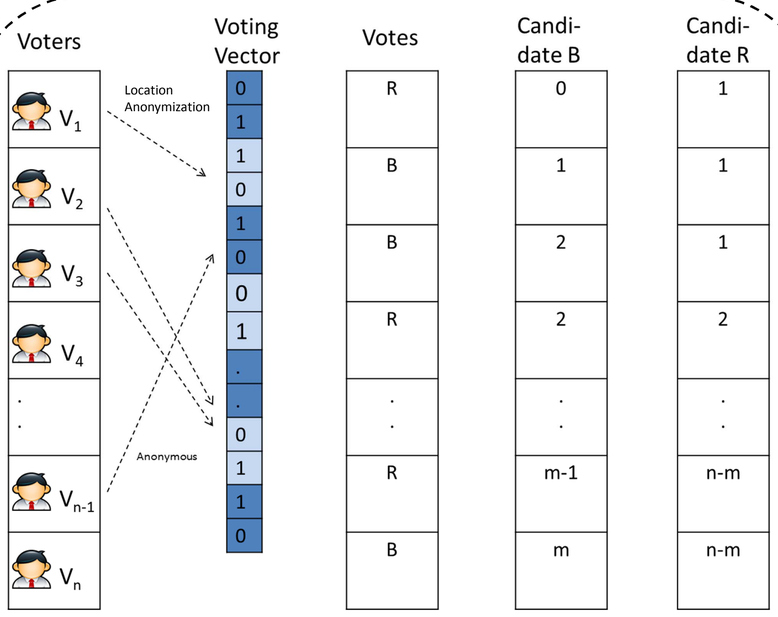
PURDUE UNIVERSITY

Mutual Restraining Voting Involving Multiple Conflicting Parties

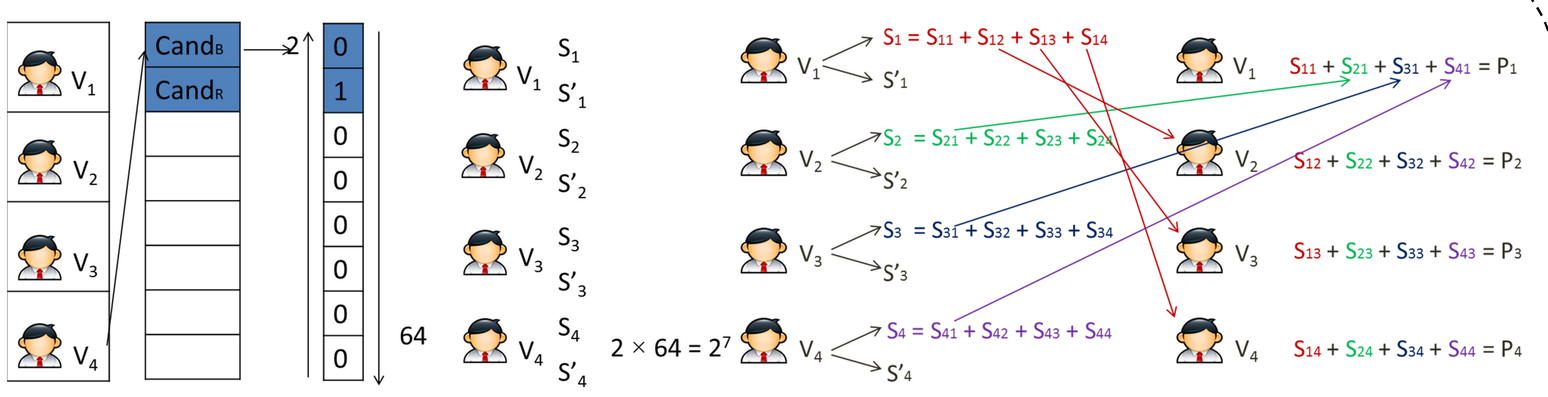
A. Problem Statement

- A gap between casting secret ballots and tallying & verifying individual votes.
- Due to disconnection between the vote-casting process and the vote-tallying process or opaque transition (e.g., due to encryption) from vote-casting to vote-tallying.
- A groundbreaking e-voting protocol that fills this gap and provides a fully transparent election.

B. Proposed protocol



TP1: Visual bulletin board: universally verifiable tallied voting vector and (incremental) tallies.

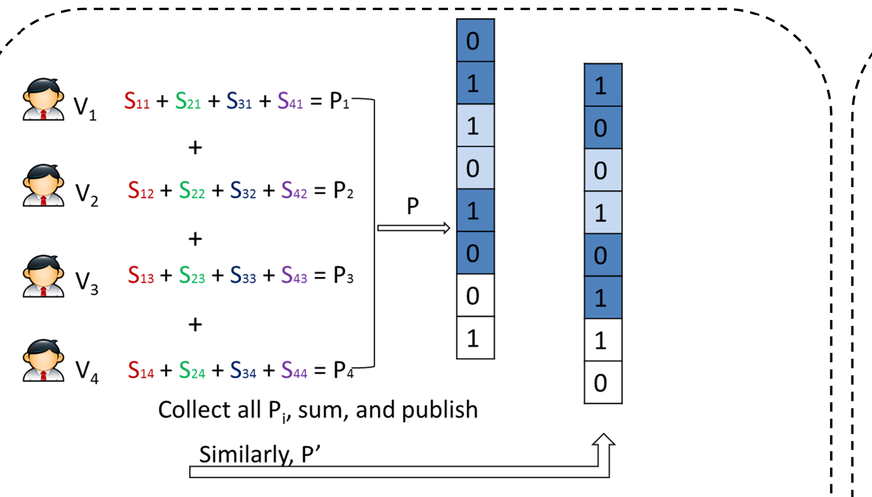


For any voter, $S_i \times S'_i = 2^{N-1}$ where N (=4 × 2=8 here) is the length of the voting vector. Enforce one and just one vote.

1. Split S_i into and distribute shares
2. Sum up received shares (and its own) and publish the result

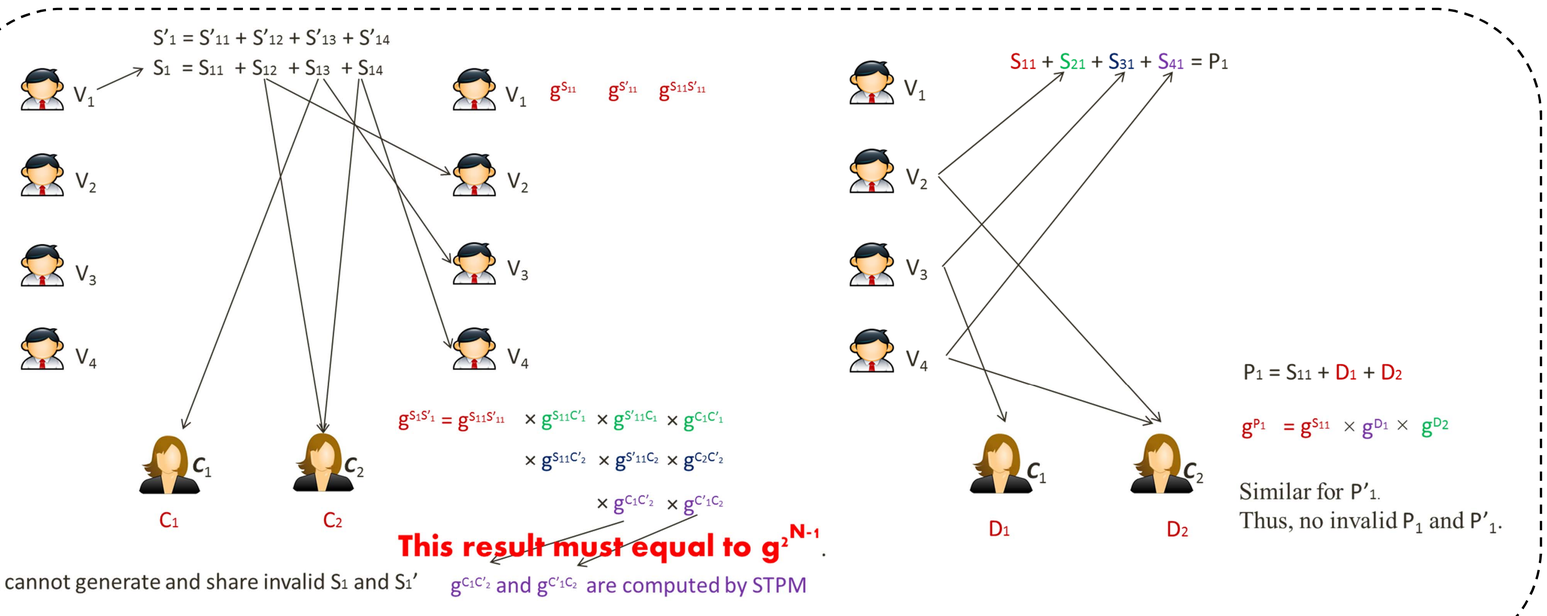
Similarly, for S'_i .

TP2: forward and backward mutual lock voting by simplified (N,N) secret sharing.



P is an reverse of P', they mutually verify and enforce each other.
Since all P_i are published, any voter can tally votes by simply summing them.

Votes collection.



TP3: in-process verification and enforcement, using Secure Two Party Multiplication (STPM).

C. A Voting Example and Web Based Dynamic Bulletin Board

Voter	Secret Location	Vote	Shares			Secret ballot
			Self-computed	Server generated		
V_1	2	B (32)	12 (=32-5-15)	5	8,7 (sum=15)	45 (=12+1+15+17)
V_2	3	R (4)	13 (=4-1-(-10))	1	-3,-7 (sum=-10)	28 (=5+13+7+3)
V_3	4	B (2)	-10 (=2-15-(-3))	15	7,-10 (sum=-3)	30 (=8+(-3)+(-10)+35)
V_4	1	R (64)	9 (=64-17-38)	17	3,35 (sum=38)	-1 (=7+(-7)+(-10)+9)

A voting example involving 4 voters and 2 candidates (R and B): Notes: shares with underline are generated by Server 1, e.g., 5 of V_1 and 7 of V_3 , and shares in red are generated by Server 2, e.g., 8 of V_1 and 15 of V_3.

Incremental aggregation

Voter	Secret Ballot	Aggregation
V_2	28	28
V_1	45	73
V_4	-1	72
V_3	30	102

1.Incremental aggregation of the cast secret ballots
2.All partial aggregations 28, 73, and 72 has no information on votes
3. Last aggregation 102 (=32+4+2+64) exposes all votes and it is the final tallied voting vector V_A

Incremental tallying

V_A	Vote	R counts	B counts
0	R	1	0
1			
1	B	1	1
0			
0	R	2	1
1			
1	B	2	2
0			

What we get?

- Seamless, viewable, verifiable, and privacy-preserving transition from vote-casting to vote-tallying
- Individual voters can verify their own votes and are technically and visually assured that their votes are indeed counted in the final tally
- Public can verify the accuracy of the count, political parties will be able to catch fraudulent votes
- Secrecy of any voter's vote is remained
- Transparent e-voting protocol: enable open and fair elections with full voter assurance, even for the voters of minor or weak political parties.

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