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Formal Verification of Cryptographic Voting Schemes

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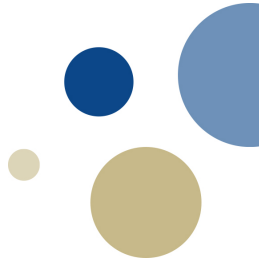
Electronic voting vs. traditional Voting



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- Relies on trust in election officials
- Counting errors
- Accessibility
- ...

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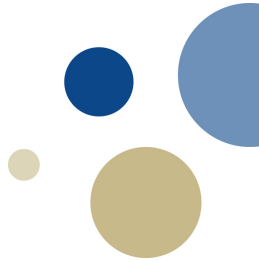

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Electronic voting may benefit from:

- Increased trust by distributed tasks
- Computer aided counting
- Public verification
- ...

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- Verifiability (cast-as-intended, counted-as-cast)
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- Integrity
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In summary: define what "secure" means and provide a security proof.

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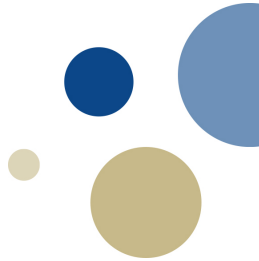

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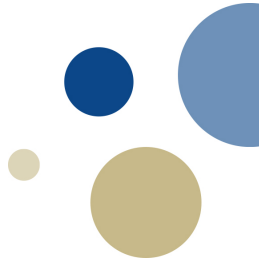

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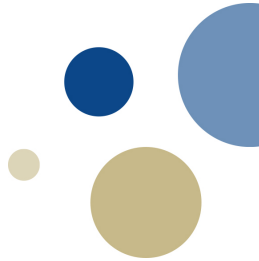
However: there may be bugs (arbitrary prime $= 1$).

EasyCrypt



EasyCrypt is a proof assistant for verifying constructions in the computational model.

Security goals and hardness assumptions are modeled as probabilistic algorithms (*games*).

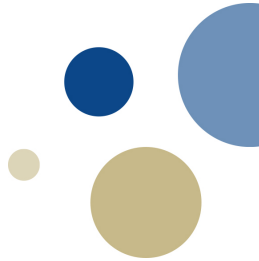
EasyCrypt has been used to verify the ballot privacy of Helios and Belenios (among others).

Goal: create a "tool-box" of formally modeled security notions and voting schemes.

A simple EasyCrypt example: Traditional voting

```
(*****************************************************************************************************)
(**** Model the voting scheme.                                                                  ****)
(*****************************************************************************************************)
module type VS = {
  proc setup()          : unit
  proc valid(id:V)      : bool
  proc cast(id:V, b:B)  : receipt
  proc tally(bb:B list) : B list
}.

module BBvoting : VS = {
  proc setup() = {}

  proc valid(id:V) : bool = {
    var ok;
    if (id \in GV.ids) {
      ok     <- false;
    } else {
      ok     <- true;
      GV.ids <- GV.ids ++ [id];
    }
    return ok;
  }

  proc cast(id:V, b:B) : receipt = {
    var ok;
    ok <@ valid(id);
    if (ok) { GV.bb <- GV.bb ++ [b]; }
    return ok;
  }

  proc tally(bb:B list) : B list = {
    var bb_n;
    bb_n <$ duniform (allperms bb);
    return bb_n;
  }
}.
```

Next steps



- Model Selene in EasyCrypt
- Define a ballot privacy model which accommodates Selene
- Prove the ballot privacy property of Selene
- Verify the proof in EasyCrypt

Thank you for your attention! Questions?