A Decentralized and Distributed E-voting Scheme Based on Cryptographic Shuffles

Decentralized and Distributed Systems Laboratory

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Way back when...

[https://heliosvoting.org/]

Helios

- Started in 2008
- First web-based, verifiable e-voting scheme
- Leverages cryptographic shuffles

Helios - Features

- Auditable elections
  - Encryption proof
  - Shuffle proof (Sako-Kilian)
  - Decryption proof
- User authentication
- Front- and back-end implementation

Helios - Verifiability

- Users can verify that their vote was counted
- Shuffle weeds out malicious servers
- Honest servers will perform decryption

Helios - Protocol

1. Cast
2. Publish
3. Shuffle
4. Audit
5. Decrypt
6. Tally

Helios - Disclaimer

- Helios does not enforce anonymity
- Voters may be subject to coercion

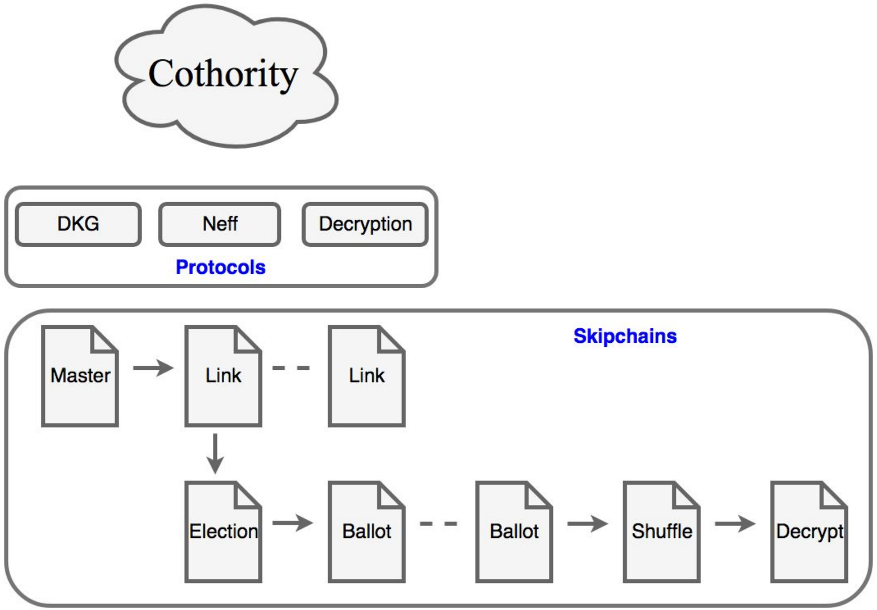
Helios - Downsides

- Centralized
- Conventional database storage
- Very slow shuffles

Helios - Improvements

- ~~Centralized~~ Cothority
- ~~Conventional database storage~~ Skipchains
- ~~Very slow shuffles~~ Neff

Back to the future



Protocols - DKG

- Distributed Key Generation
- Create public/private key pair
- Split private key
- Part of kyber library

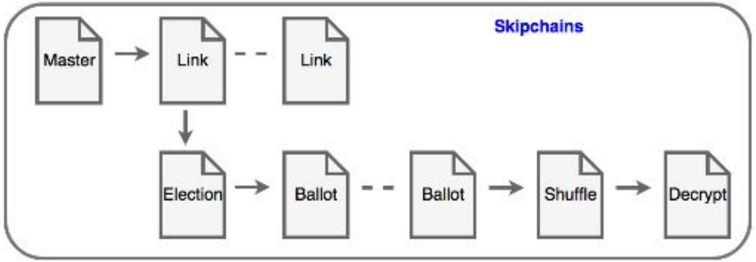
Protocols - Neff Shuffle

- Novel verifiable shuffle concept by Andrew Neff
- Orders of magnitude faster than Sako-Kilian scheme

Protocols - Decryption

- After election termination and audit
- Reconstruct plaintext ballots with shared secret keys
- Cannot be done by a single node

Storage



- Master
  - System configurations
  - List of admins, roster etc.
- Link
  - Reference to election skipchain
- Election
  - Settings
  - DKG public key, list of voters etc.
- Ballot
  - Casted vote (one per block)
- Shuffle
  - Permuted and re-encrypted ballots
- Decrypt
  - Ballot plaintexts

Practical

- Go implementation
- Built on top of cothority and kyber
- Protobuf API

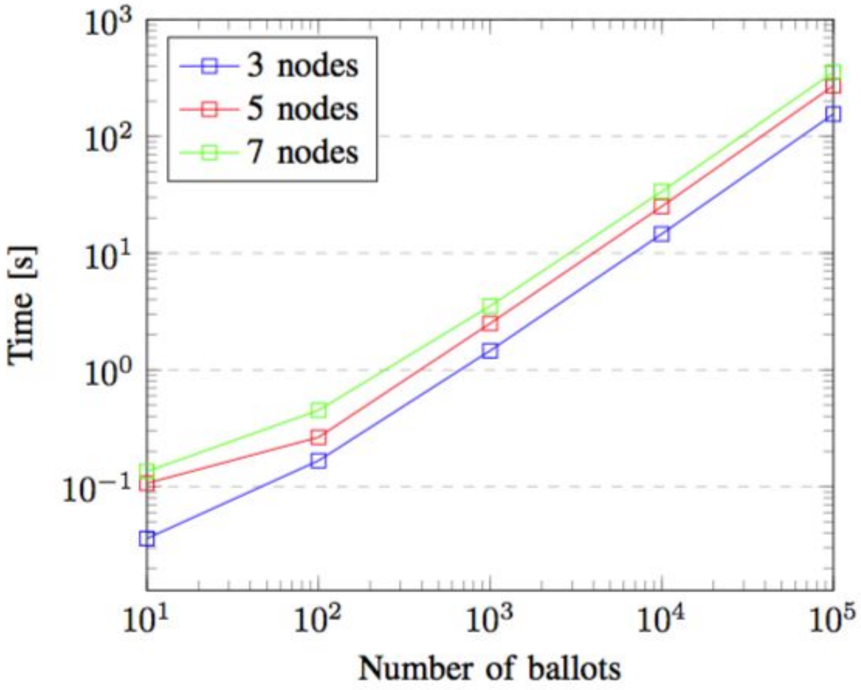
Benchmarks - Helios

- Shuffle of 500 ballots ~130s
- 2.2 GHz dual core machine

[Ben Adida. Helios: Web-based open-audit voting]

Benchmarks

- Shuffle
- 1.4 GHz dual core
- Real world context?



Overview

- Distributed e-voting scheme
- Improves on Helios
    - Distributed
    - Faster
- Built on top of DEDIS infrastructure

Gory details

- Cryptographic background
    - Framework (elliptic curve etc.)
    - Shuffles
    - Verifiability
- Protocols
    - Networking
- Usage
    - Authentication
    - Front-end

References

- Repository: https://github.com/dedis/student_17_evoting
- Report: https://github.com/dedis/student_17_evoting/blob/master/report.pdf