
DTU

Marvin Beckmann, Christian Majenz

Fully Anonymous Ring Signatures in the QROM

Example: Whistleblowers

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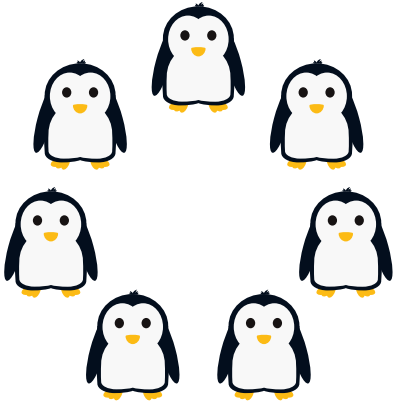
Deniability and Authenticity

Ring Signatures



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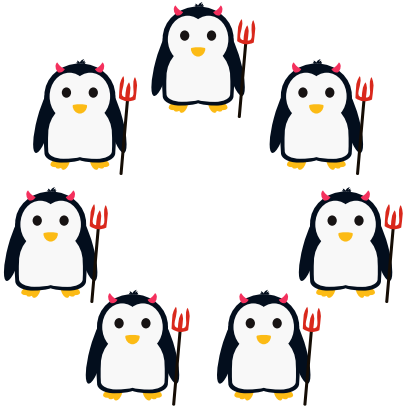

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- (deniable) authenticated key exchange (e.g. for Signal [8])

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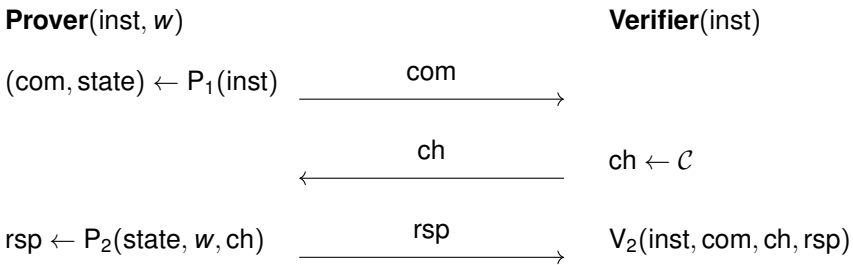
(1) AOS-transform [1] and (2) Ring Trapdoor Functions

Sigma Protocols



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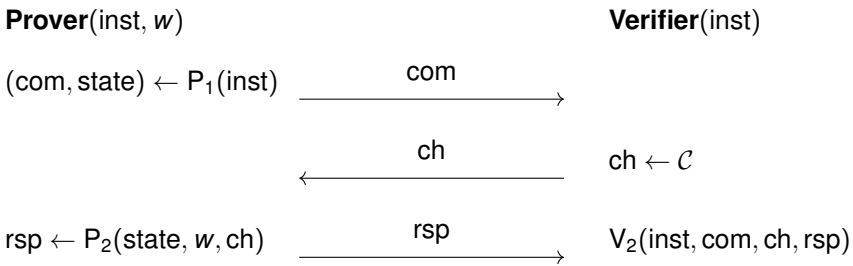

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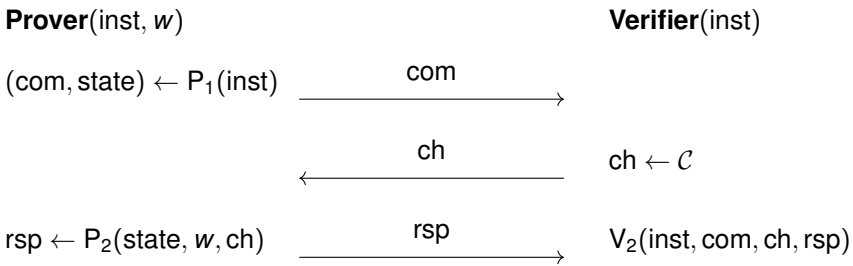

- Impersonation, . . . , witness recovery, HVZK simulator (with min-entropy)
- To make a signature scheme: Fiat-Shamir transform

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$\mathsf{Sign}(\mathsf{sk}_i = w_i, \rho = \{\mathsf{inst}_1, \ldots, \mathsf{inst}_N\}, \mu)$

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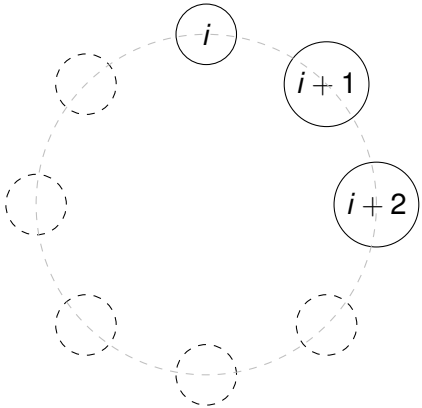

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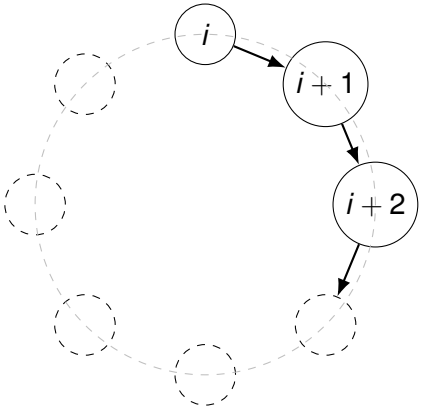

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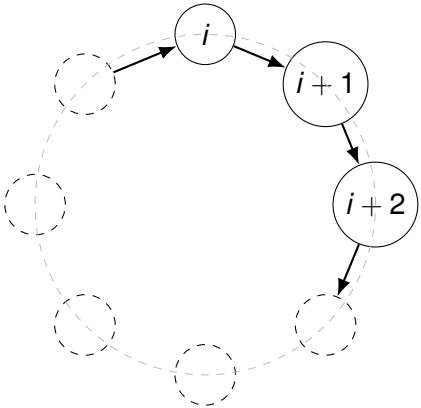

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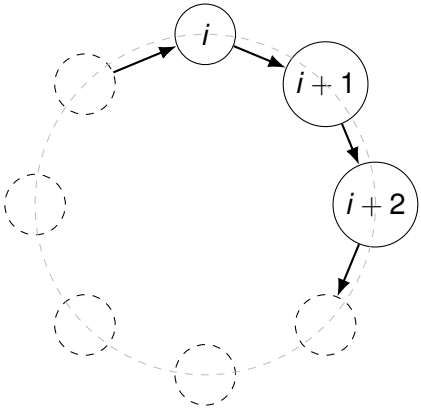

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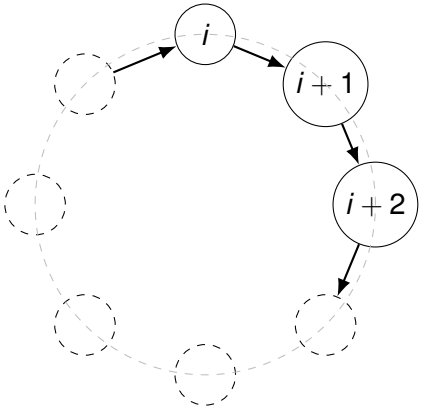

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   - general approach: using measure-and-reprogram [4], get an order of all queries from a forgery[1]
   - alternative approach: assume commit-and-open sigma protocols: use framework [3] based on Zhandrys compressed oracle slightly adjusted in [5] [2]

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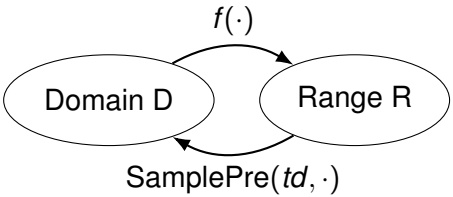
- interested in a search problem: generate a valid transcript without possible extractions
- compressed-oracle formalism (classical analogue: query lists)
  - analyse probability of database satisfying search problem
  - depends on maximal fraction of challenges that can be answered for a fixed commitment without extraction being possible

Yay, QROM Proofs for AOS Ring Signatures!

Trapdoor Functions and PSFs [6]

- f is one-way
- SampePre returns preimages under f



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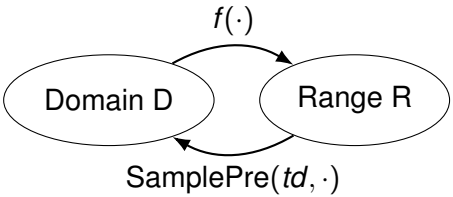

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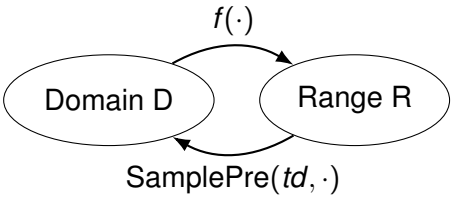

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- Each party in ρ has a trapdoor for f_ρ
- We again define PSF-like properties[3]

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Ring Trapdoor Functions for Ring Signatures

Sign(sk, ρ, m)

1 : $s \leftarrow \{0,1\}^{\lambda}$
2 : $h \leftarrow \mathsf{H}(\rho, s, m)$
3 : $\sigma \leftarrow \mathsf{SamplePre}(\mathsf{sk}, \rho, h)$
4 : **return** (s, σ)

[a] requires statistical distance ϵ and yields additive term of $\approx q^2\sqrt{\epsilon}$

Ring Trapdoor Functions for Ring Signatures

1. query simulation strategy
   - sample in domain D_ρ and apply f_ρ
   - do a history-free proof [2]; use randomness (deterministically derived from ρ, s, m) for domain sampling [a]

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Summary

QROM proof for

- AOS-transform
  - General bound with multiplicative term of q^{2N}
  - Commit-and-open additive term
- Preimage sampleable ring trapdoor function
  - only work with statistical distance [a]

[a] We are working on changing this

References I

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