# Scalable Registration-Based Encryption from Lattices

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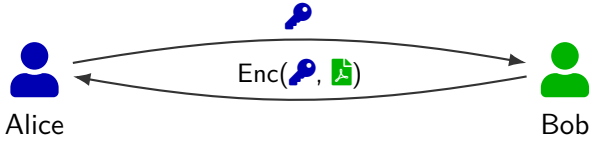
May 20, 2026



# PKI based on Public-Key Encryption



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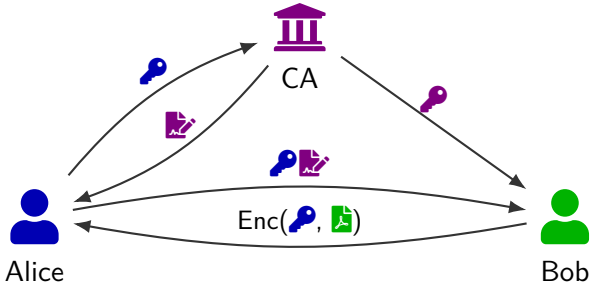

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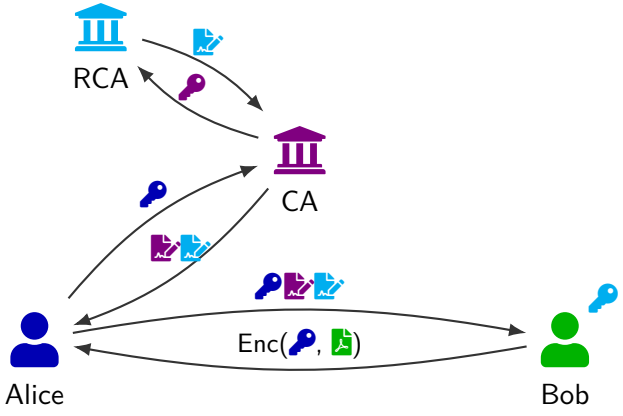

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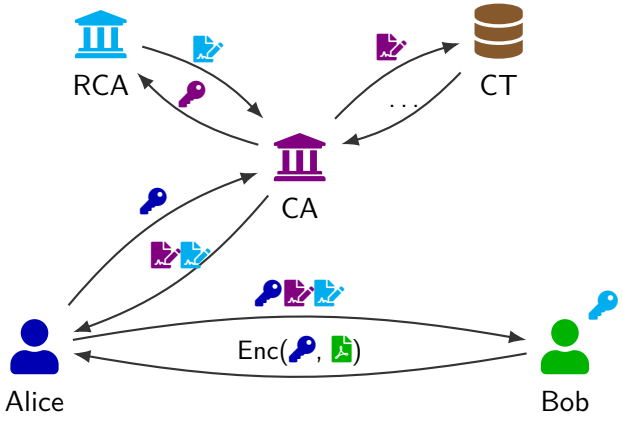


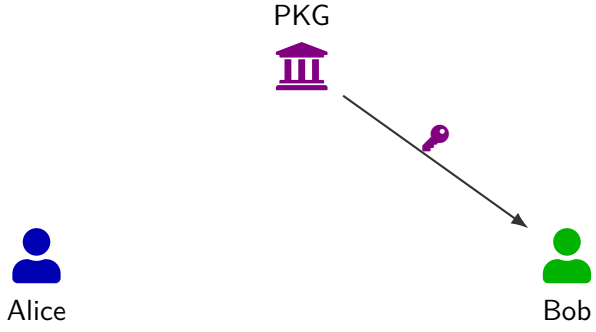
# PKI based on Identity-Based Encryption [Sha84]

PKG

Alice

Bob

# PKI based on Identity-Based Encryption [Sha84]



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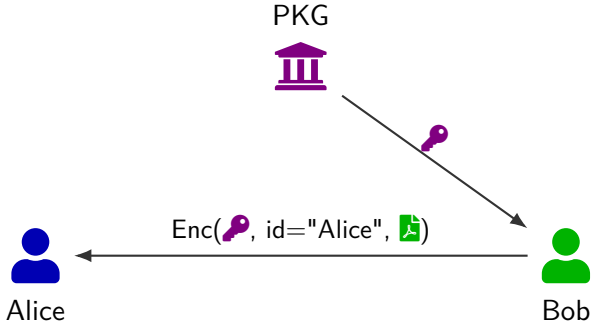

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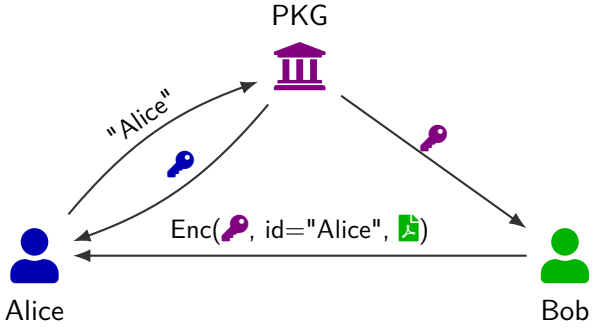

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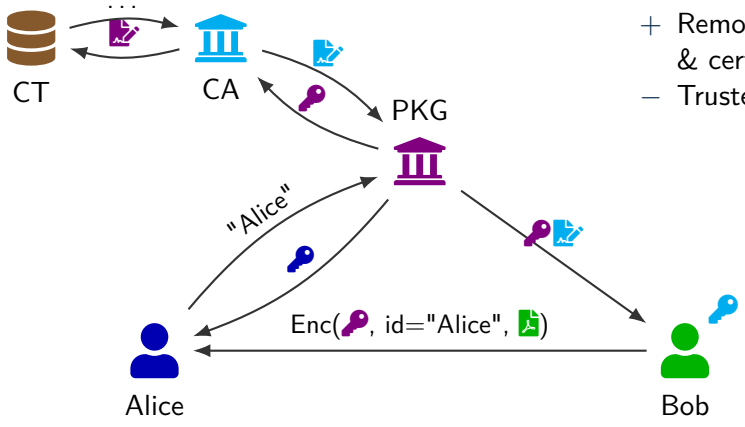
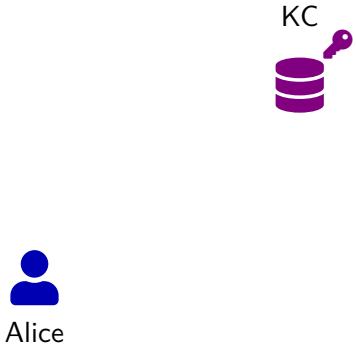



+ Removes individual keys & certificates
− Trusted PKG

# PKI based on Registration-Based Encryption [GHMR18]



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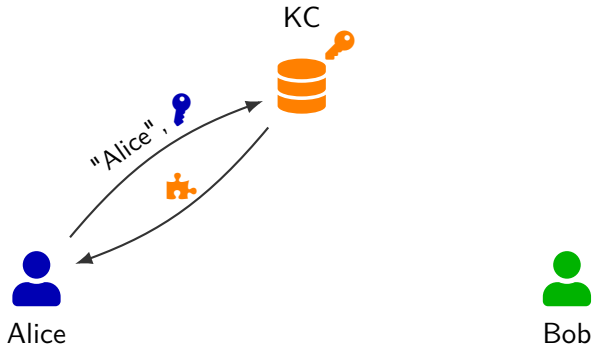

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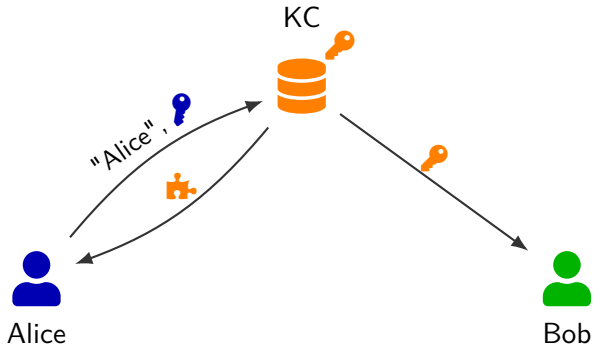

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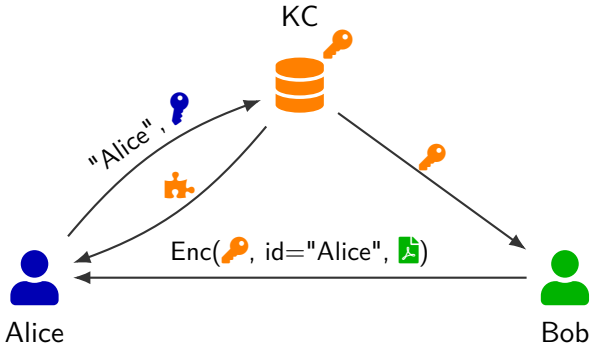

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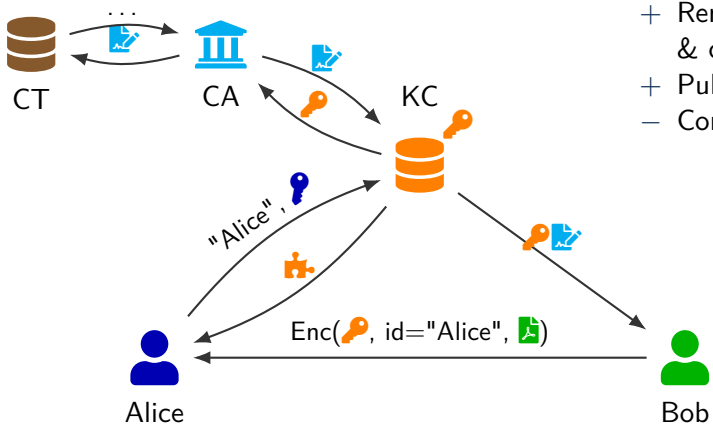



+ Removes individual keys & certificates
+ Publically auditable KC
− Communication overhead

# Constructing an RBE

Generic compiler: Derive RBE from multi-instance of Laconic Encryption (LE)

**Recipe to Construct Laconic Encryption**

Ingredients

- Vector Commitment (VC)
- Public-Key Encryption (PKE)

Instructions

- Enter public key of id in the id-th entry of VC
- Encrypt with respect to that entry

$\Rightarrow$ Decryption works only with corr. opening and secret key of corr. entry

# Our Work

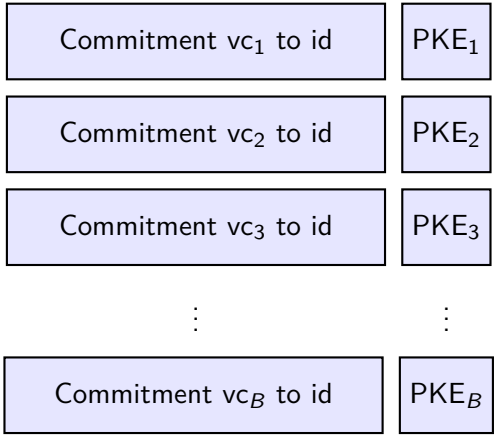
# Foundation

Build on DKLLMR scheme [DKL+23]

+ Security based on SIS and LWE
+ Transparent setup
+ Naturally extends to support arbitrary identity spaces
+ Only known post-quantum construction
− Ciphertext size of 7.2 GB for our setting

# Optimisation 1: Batching Parts of Ciphertext

**Shape of Ciphertext**



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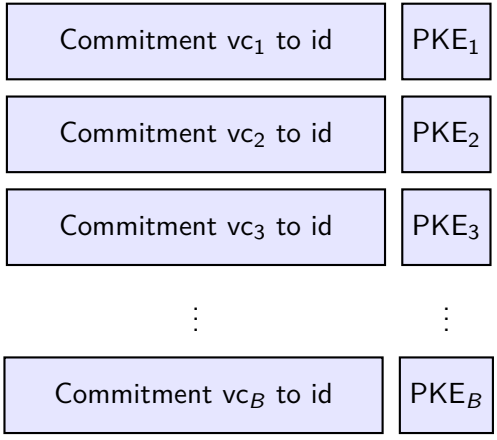
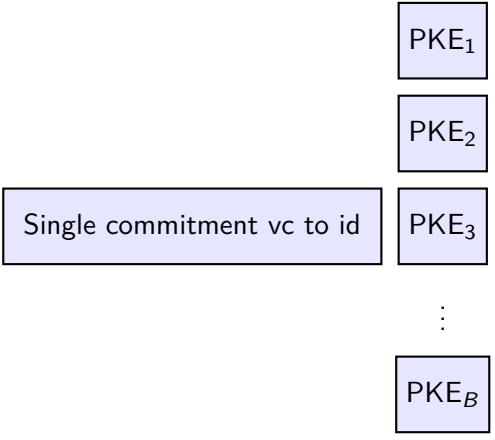



**Batch Commitments to same** id by sharing randomness across LE instances



# Further Optimisations

2. Remove lower-order bits of ciphertext
3. Replace statistical arguments in security proof by computational ones
4. Utilise approximate gadget matrices rather than exact ones

$\Rightarrow$ Ciphertext size of 7.0 MB for 128-bit security

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- Scalable: Increase number of users to $2^{128}$ $\Rightarrow$ Ciphertext size of 7.1 MB

# Practical Confirmation of Approach

Practical confirmation via open-source prototype in Rust

Further practical optimisations

- Hardware-accelerated NTT multiplication
- Optimised memory layout of registry, minimising numbers of NTT transforms
- Multi-Threading of Enc

| | | Time (milliseconds) | | | | | |
|---|---|---|---|---|---|---|---|
| | $\varphi$ | Setup | KeyGen | Upd | Enc | WGen | Dec |
| Ours | 256 | 9.98 | 0.12 | 33.24 | 15.56 | 3.38 | 10.43 |

Table: Benchmarks for RBE schemes in comparison.

## Closing Remarks

**Open Problem**

- Ciphertext size is dominated by length of identity due to choice of VC

$\Rightarrow$ Replace VC by more succinct VC

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**Thanks for your Attention!**

**Paper**

https://ia.cr/2026/717

**Implementation**

jnsiemer/scalable_rbe_prototype

# Main References



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