Blinding Post-Quantum Hash-and-Sign Signatures

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Blind Signature Schemes

The Authority

Authority's private key

The User

Message to sign

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Commitment of the message

① The User **commits** the message to sign.

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Message **signed**

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Unforgeability: After interacting with the authority to obtain signatures on a set of messages, the user should remain unable to forge a valid signature on any new message by itself.

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Blindness: The authority must be unable to learn either the content of the message being signed or the resulting signature.

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It has applications in many **privacy-enhancing technologies** (PETs), such as electronic voting systems.

The Fischlin Framework (simplified)

[Fis06] Fischlin. Round-optimal composable blind signatures in the common referee string model. CRYPTO 2006.

The Authority

Authority's private key sk

The User

Message m to sign

① $\text{com} \leftarrow \text{Commit}(m; r)$

com

② $\sigma \leftarrow \text{Sign}(\text{sk}, \text{com})$

σ

③ Generate a proof π that he know σ and r such that

$\text{Verif}(\text{pk}, \sigma, \text{Commit}(\text{m}; \text{r})) = 1.$

The final signature is π.

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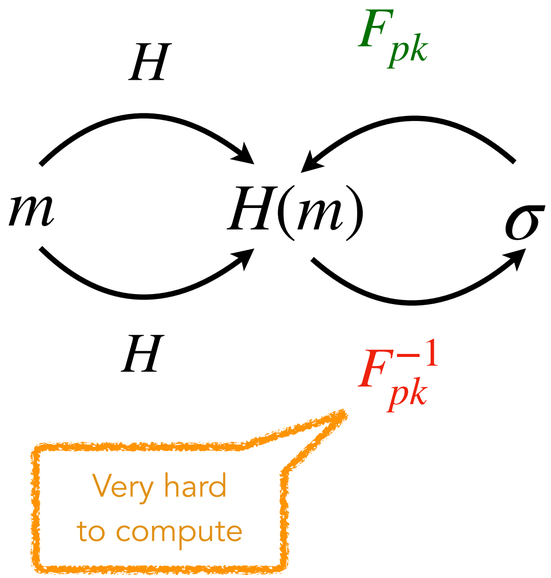
The overall performance (proof size, running times) will highly depend on how complex is the verification algorithm.

Post-Quantum Hash-and-sign signatures



Examples:

- Falcon / FN-DSA (lattice)
- Wave, Miranda (code)
- UOV, Mayo (multivariate)

Proving knowledge of signature:

Denoting $h' := H(m)$,

The User proves that he knows σ and h' such that

$$h' = H(m) \quad \text{and} \quad h' = \mathcal{G}_{pk}(\sigma)$$

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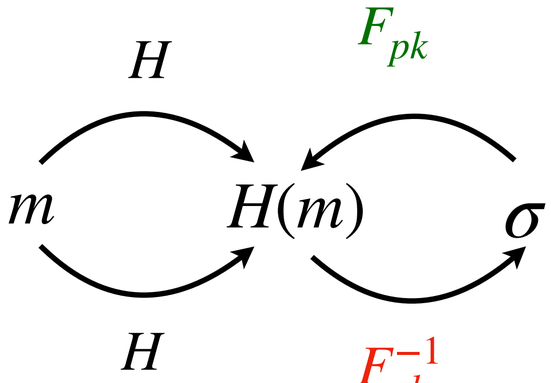

Very hard to compute

Easy to prove, as it is an algebraic relation

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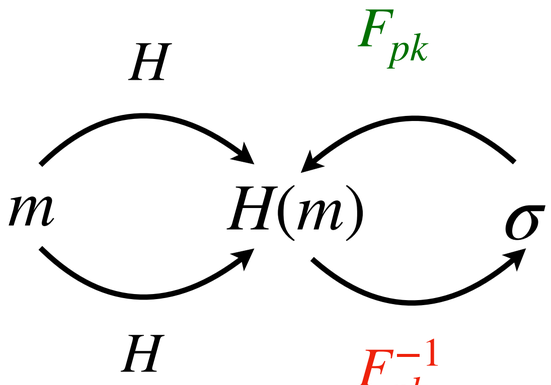

Very hard to compute

More ***complex/expensive*** to prove

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Prior work

[BLNS23] Beullens, Lyubashevsky, Nguyen, Seiler. Lattice-based blind signatures: Short, efficient, and round-optimal. CCS 2023.

> [BLNS23] succeeds in removing the need to prove correctness of the hash computation within the proved statement.
>
> $$\begin{aligned} \text{com} &\leftarrow \text{Commit}(m; r) \\ &:= Br + H(m, H(r)) \end{aligned}$$
>
> with r small and B a public matrix, and by removing the hashing in the signing routine.

Drawbacks:

- The security of the construction relies on **lattice assumptions**, and can ***not*** be generalized with other types of security assumptions.
- The security of the scheme can not be reduced to the security of a well-known hash-and-sign signature scheme.
- It still produces ***quite large*** blind signatures (22 kilobytes).

Contributions

Based on the ideas of [BLNS23], we propose a **new construction for blind signatures** that offers several advantages over [BLNS23]:

- It enables the transformation of ***any*** post-quantum hash-and-sign signature scheme into a blind signature. It relies on a commit-and-prove (CP) scheme.

$$\begin{aligned} \mathrm{com}_0 &:= \mathrm{CP}.\mathrm{Commit}(r;\rho) \\ \mathrm{com} &:= r + H(m, \mathrm{com}_0) \end{aligned}$$

  The user needs to send a SNARK proving that com has been well-built (also true in [BLNS23]).

- The security of the resulting blind signature can be ***reduced to that of the original signature scheme***, without introducing additional assumptions.

- It yields ***efficient multivariate blind signatures*** ($\approx 5 - 8$ KB), when applied to UOV-like signature schemes.

Comparison - Multivariate Blind signatures

Comparison with more recent works

	Same security as the original scheme	*Signature Size*	*Communication Size*
Our Work	Yes	5-8 KB	Few MB
[BFMR+25]	No	7 KB	< 1 KB
[BBBMR26] Conservative	Yes	24 KB	< 1 KB
[BBBMR26] Non-conservative	No	6-7 KB	< 1 KB

Based on the trade-offs targeting short signatures

[BFMR+25] Bouillaguet, Feneuil, Maire, Rivain, Sauvage, Vergnaud. Multivariate Commitment and Signatures with Efficient Protocols. ePrint 2025/2035.

[BBBMR26] Baum, Beckmann, Beullens, Mukherjee, Rechberger. Concretely Efficient Blind Signatures Based on VOLE-in-the-Head Proofs and the MAYO Trapdoor. ePrint 2026/109.

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Based on the trade-offs targeting short signatures

Our work enables the construction of short blind signatures without introducing any additional security assumptions.

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The proved statement must include the correctness of the hash operation, which results in a **large** signature.

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Based on the trade-offs targeting short signatures

The trade-off is a **substantial** communication overhead between the user and the authority, caused by the use of a generic SNARK to prove that the user's commitment is correctly constructed.

Note: since the literature of SNARK is evolving fast, we might expect improve on that point.

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Based on the trade-offs targeting short signatures

Need to be stored
Will be used in many protocols

Do not need to stored
Can be deleted after the protocol

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Thank you for your attention.