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Practically Efficient Private Set Intersection From Trusted Hardware with Side Channels

Felix Dörre, Jeremias Mechler, and Jörn Müller-Quade | 6. December 2023

Private Set Intersection

All Icons by Pixel perfect, Eucalyp, Smashicons, monkik, Freepik, itim2101 from flaticon.com

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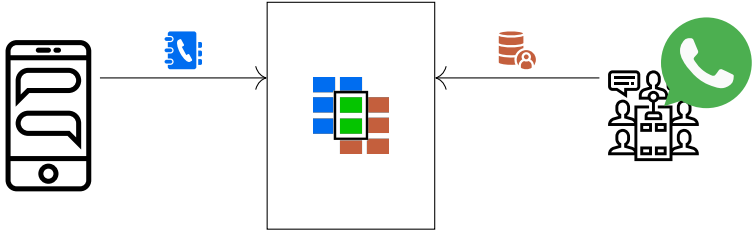

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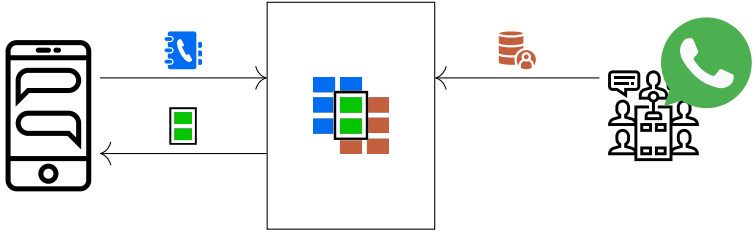

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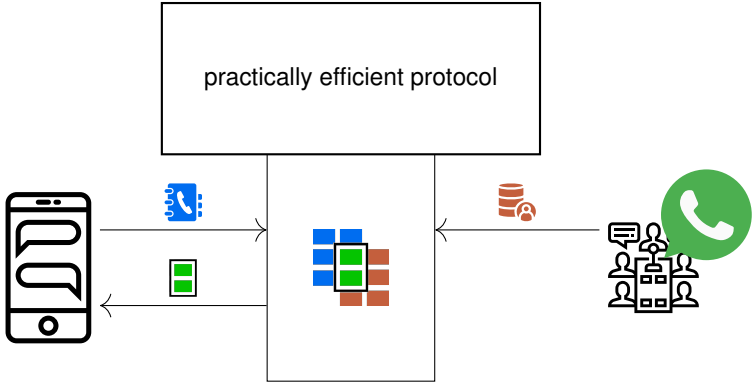

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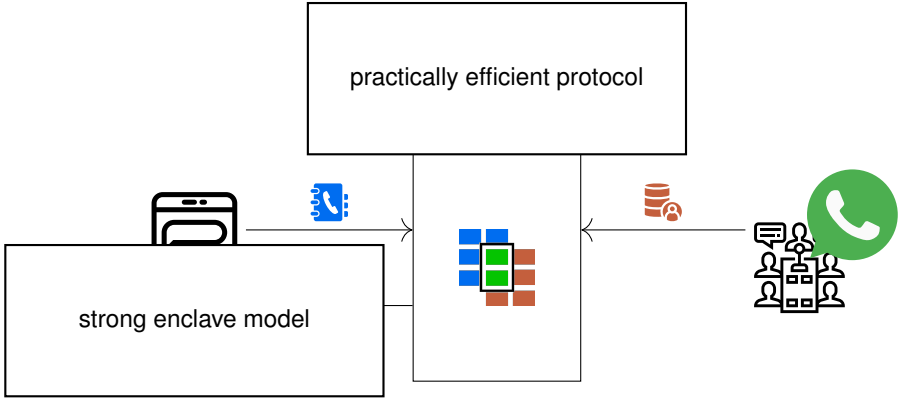

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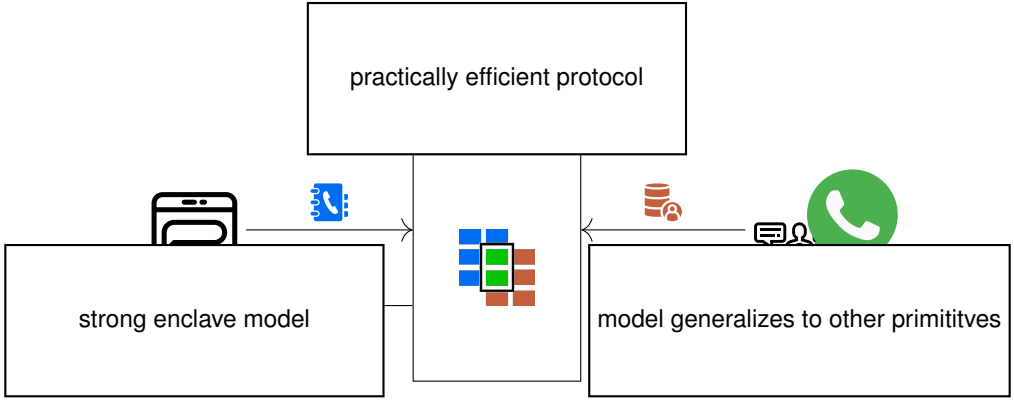

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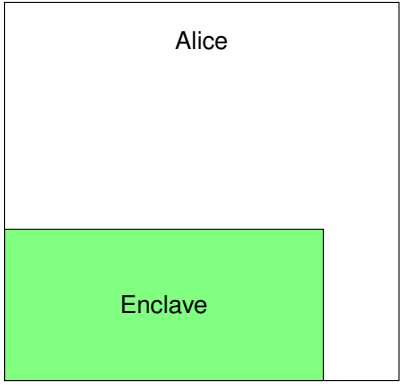
Many efficient PSI protocols use Random Oracles

Recent PSI protocols: [RR17; Pin+20; Gar+21; RR22].

- Random Oracles are a very strong assumption.
- Provably cannot be instantiated by a cryptographic hash function. [CGH98; CGH04]
- Advanced protocols use special properties that may not hold for cryptographic hash functions.

Secure Enclaves: Model



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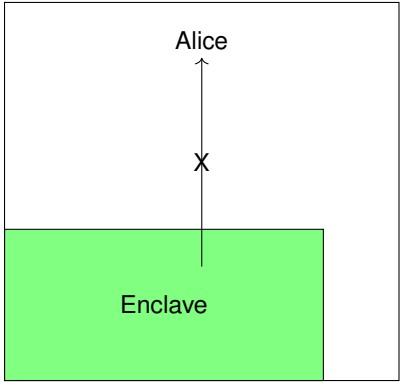

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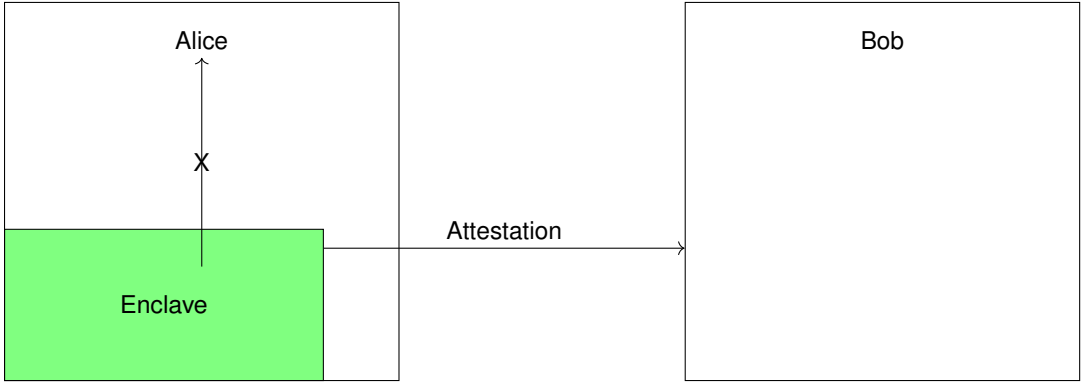

Assumption: Secure Enclaves (a closer look)

- Enclaves promise confidential and correct execution at near-native speed.
- However various side-channel attacks that routinely need to be mitigated [NBB20].
- Some side-channels like memory-access patterns are accepted.
- Formal Models: regular [PST17], transparent [Tra+17]

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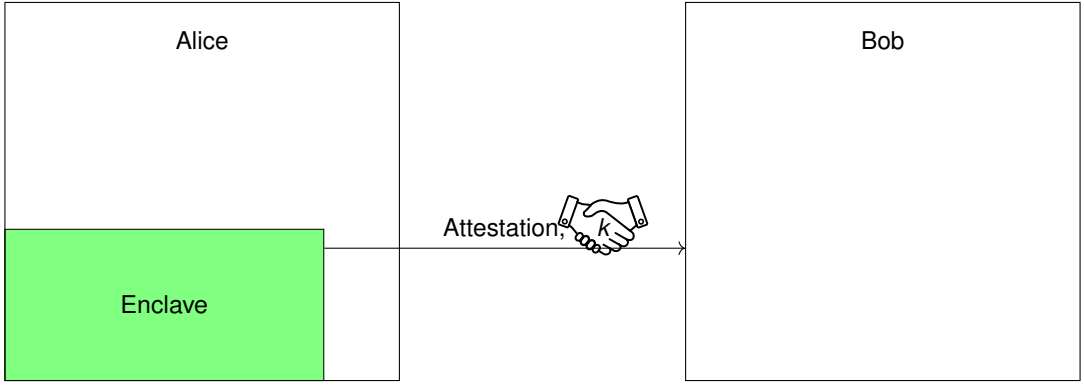
Definition: Almost-transparent Enclave (informal)

An enclave that leaks:

- all random bits generated internally
- the enclave memory before execution
- the output of all secure operations

Naïve Approach



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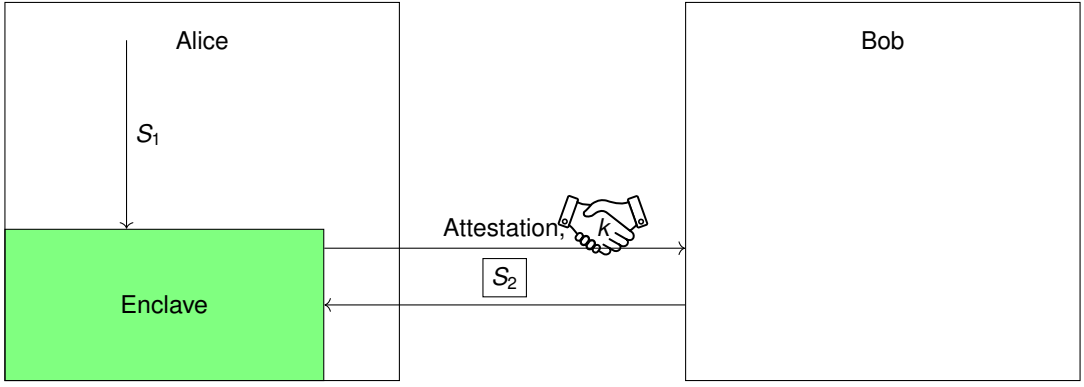

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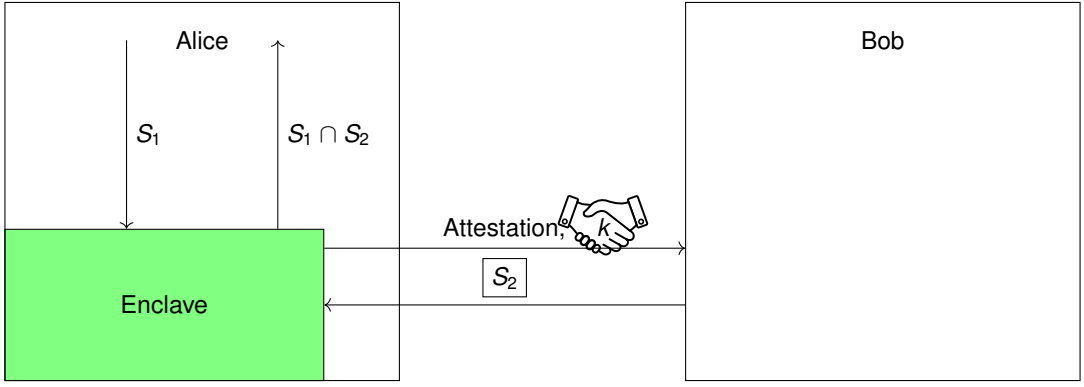

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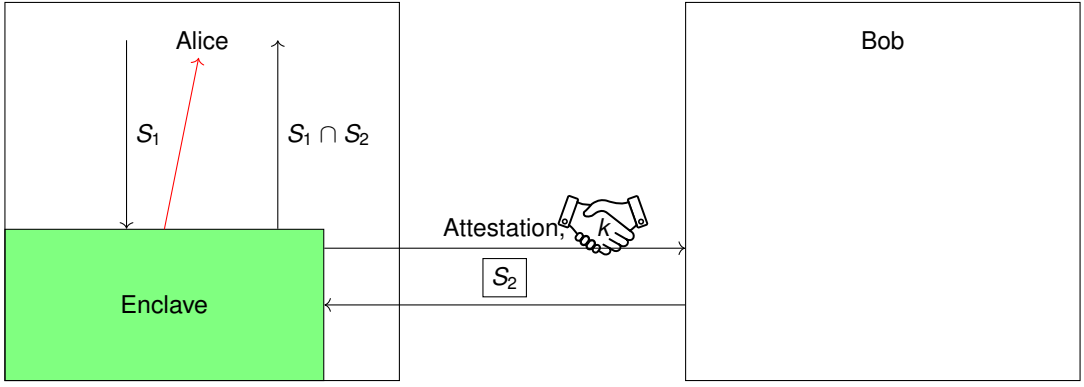

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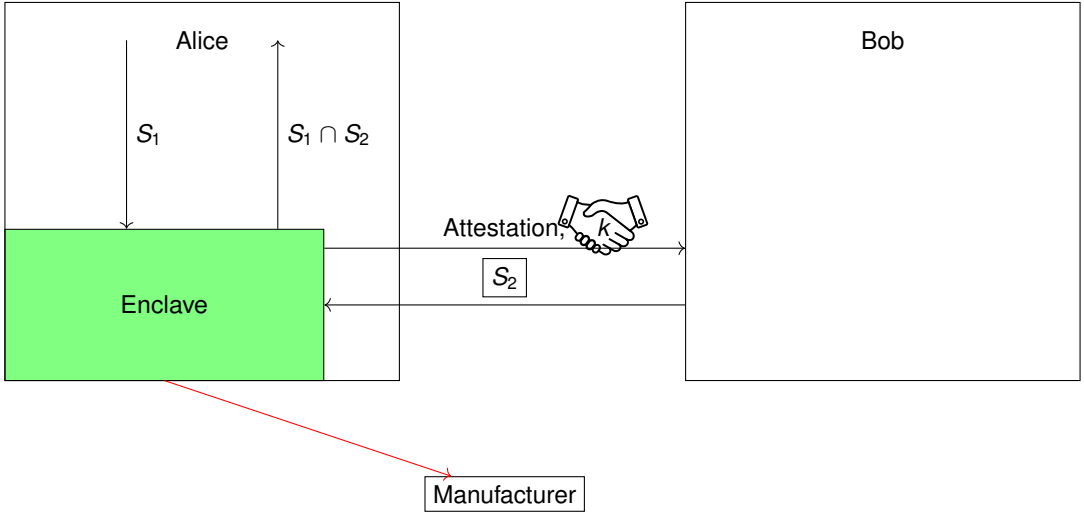
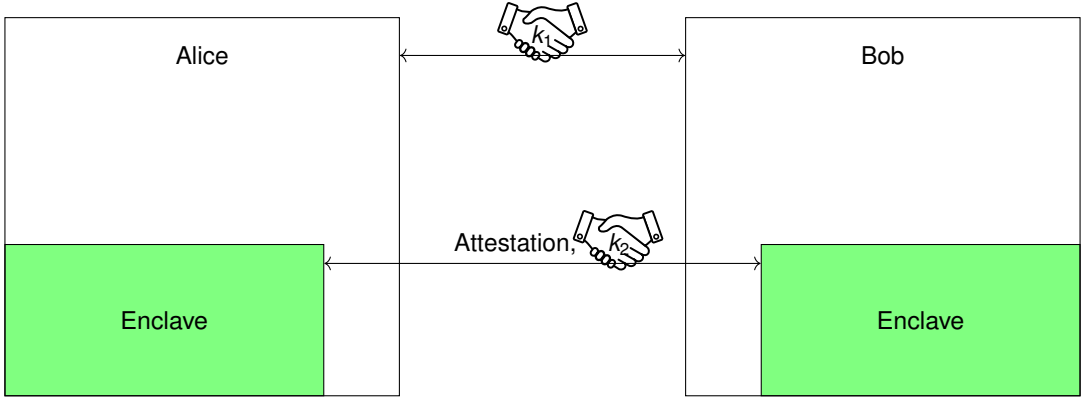


Slightly Better Approach



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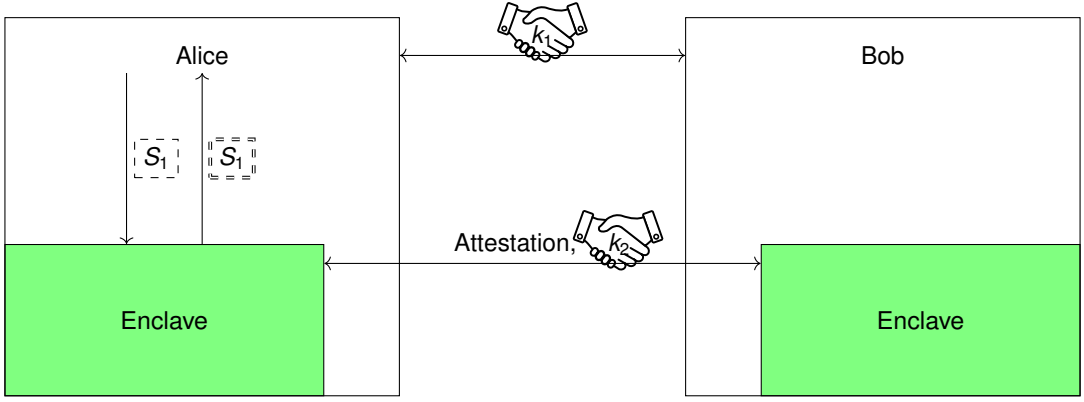

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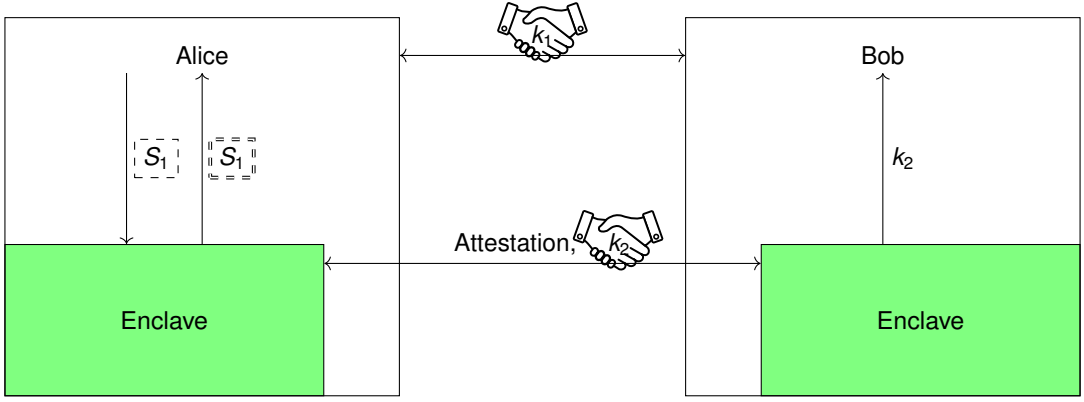

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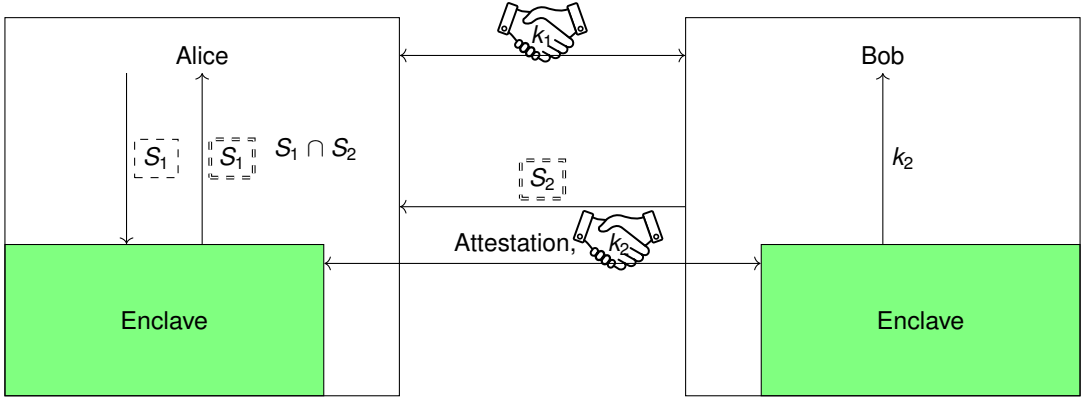

Implementation

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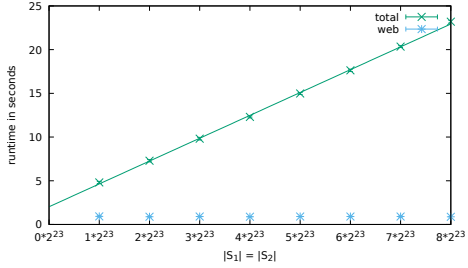

Figure: Runtime of the PSI protocol, depending on the number of elements in the input sets for elements of 128 bit size.

Summary

- fastest, practically efficient PSI protocol
- strong security model for enclaves: secure operations + full leakage to external party
- constructed variants, like limiting input sizes, realizing a trusted initializer or calculating hamming distance.

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