ETH zürich

Giving an Adversary Guarantees (Or: How to Model Designated Verifier Signatures in a Composable Framework)

Ueli Maurer, Christopher Portmann, Guilherme Rito

Asiacrypt' 21

Outline

Introduction

Security notions typically restrict what dishonest parties can do.

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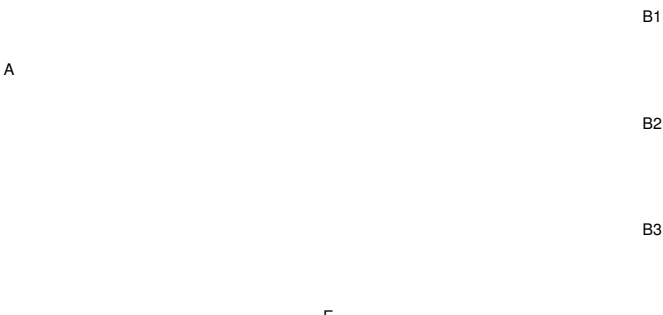

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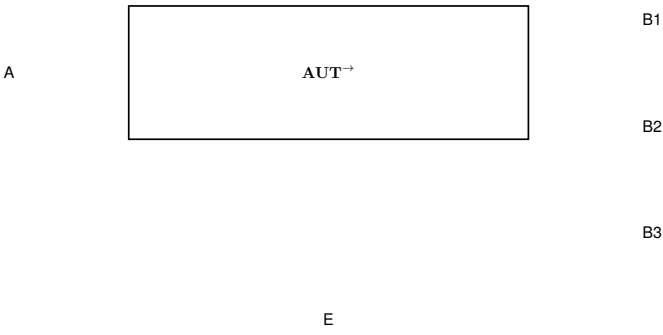

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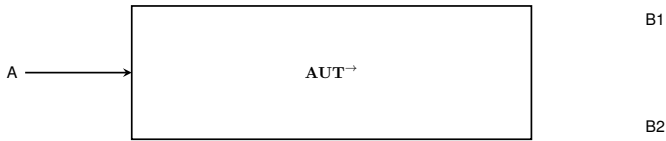

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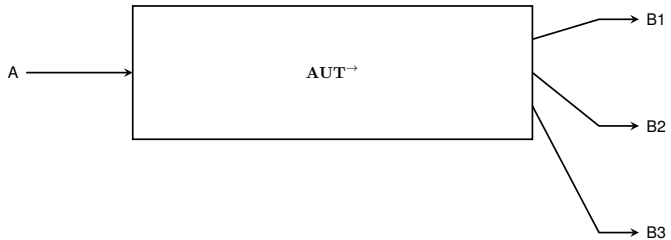

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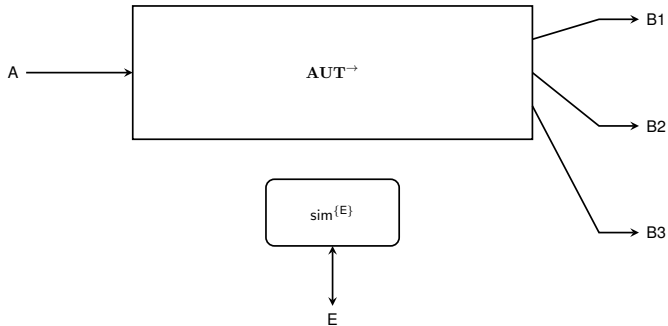

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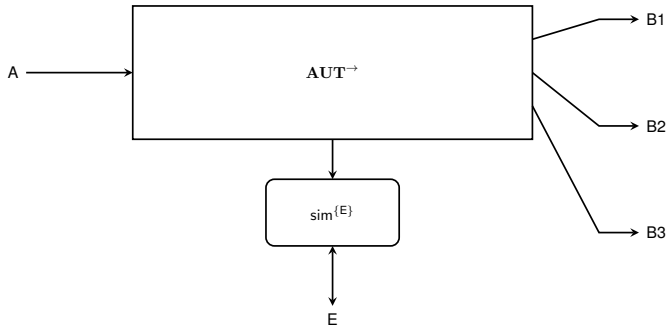

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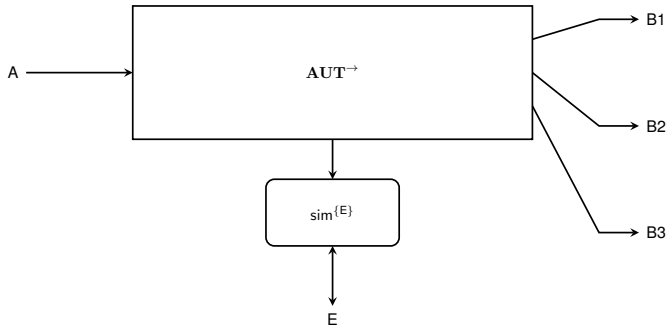

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Off-The-Record does not violate Authenticity:

Off-The-Record: Eve cannot tell if Alice sent a message
Authenticity: **honest Bobs can!**

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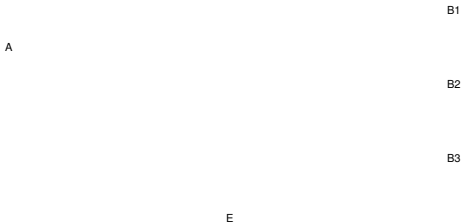
How to model the Authenticity and Off-The-Record guarantees?

Introduction — Capturing Authenticity and Off-The-Record



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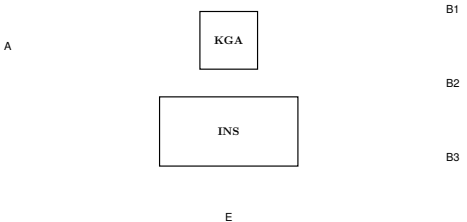

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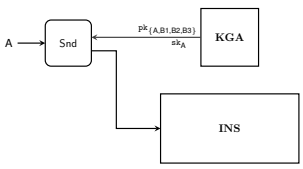

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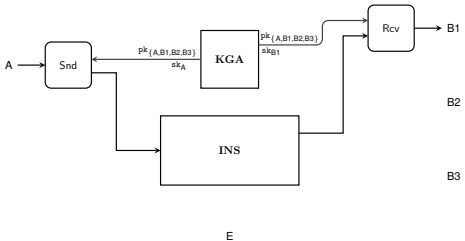

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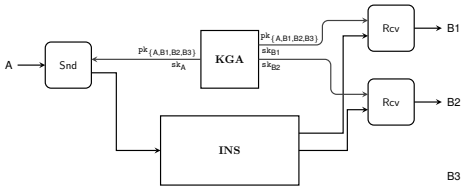

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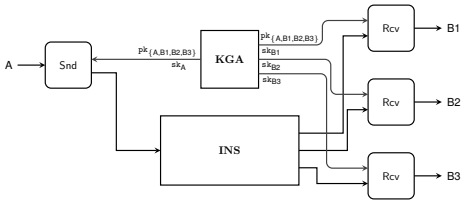

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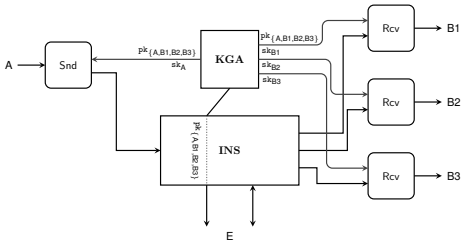

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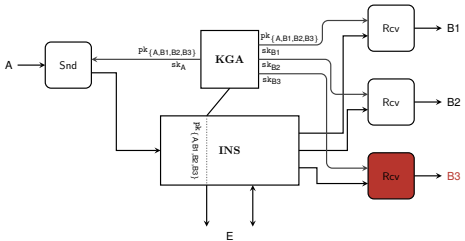

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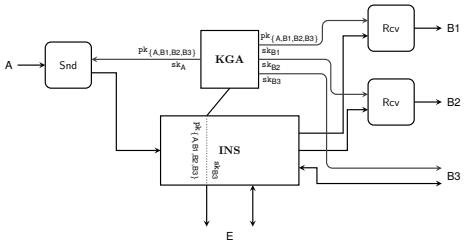

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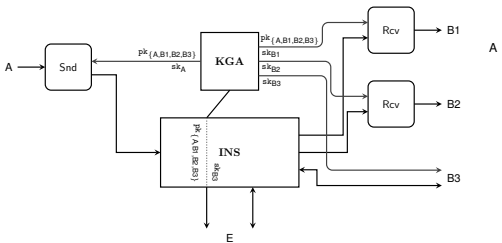

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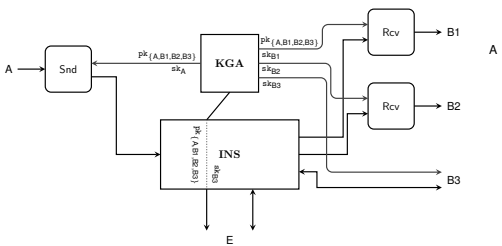

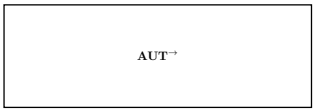

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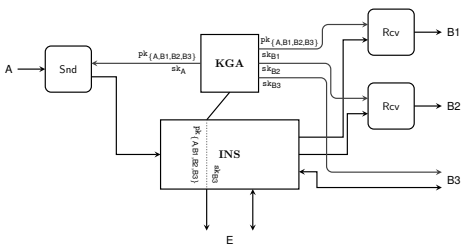

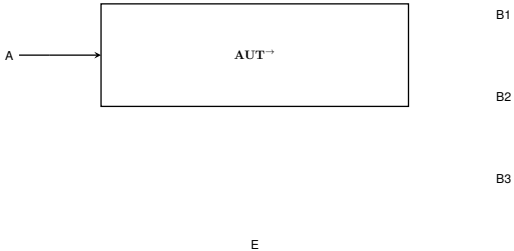

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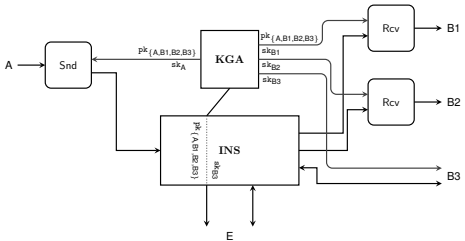

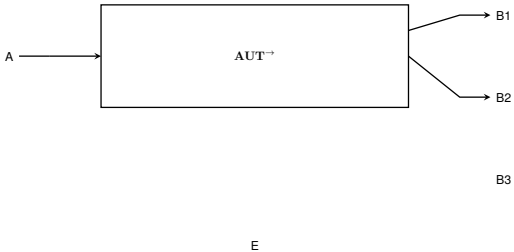

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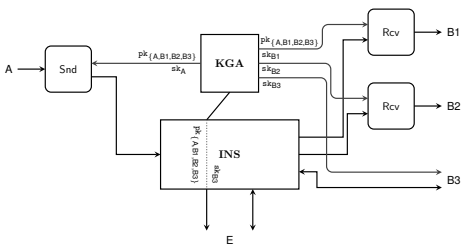

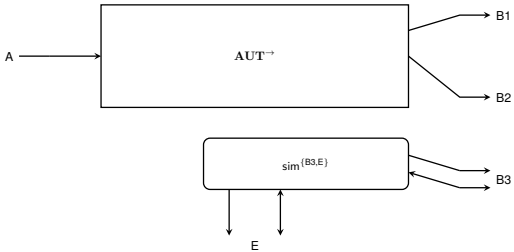

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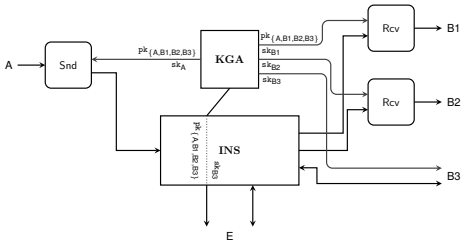

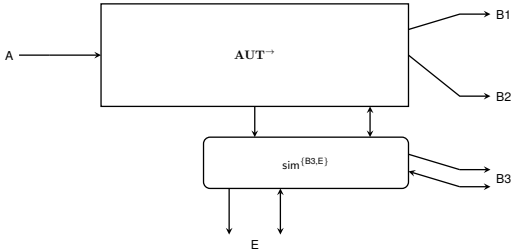

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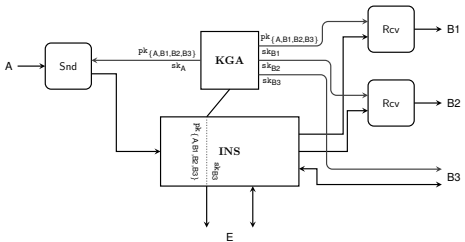
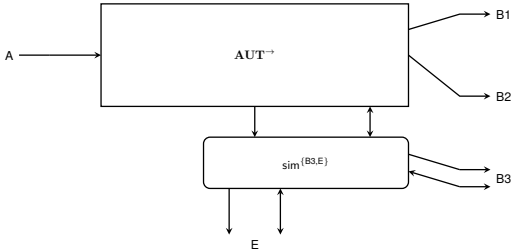
Problem: Any Unforgeable Signature Scheme satisfies this composable notion.





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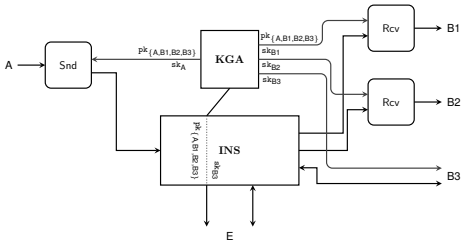

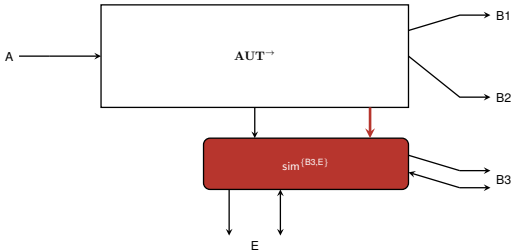

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Our approach: By using the notion of specifications (introduced by Maurer and Renner [2]).

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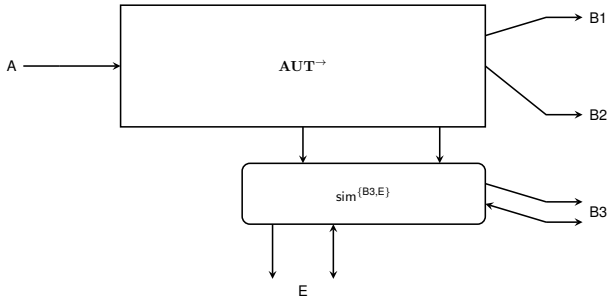

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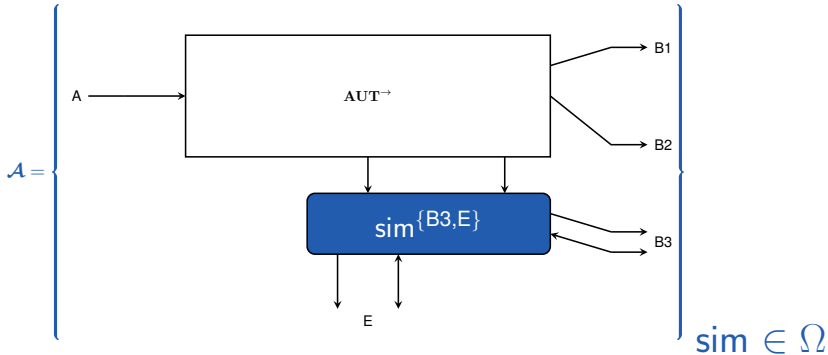

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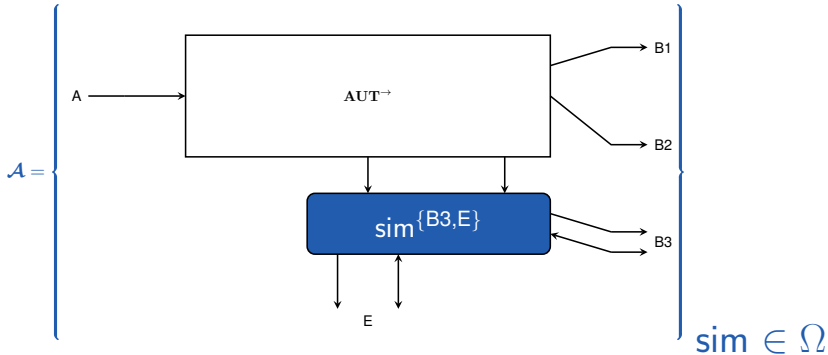

If an honest Bob reads a message, then Alice wrote it.

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The ideal world is an **intersection** of specifications!

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Comparison against existing security notions for MDVS. We find that:

- Only the notions introduced by Damgård et al. [1] capture the security of MDVS;
- Our notions are strictly weaker than Damgård et al.'s.

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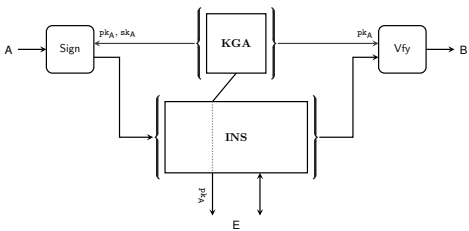

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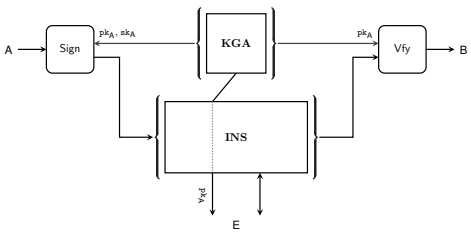

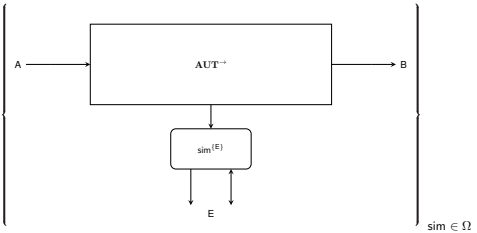

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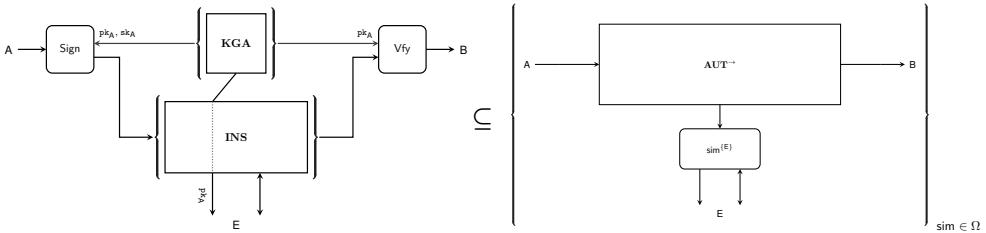

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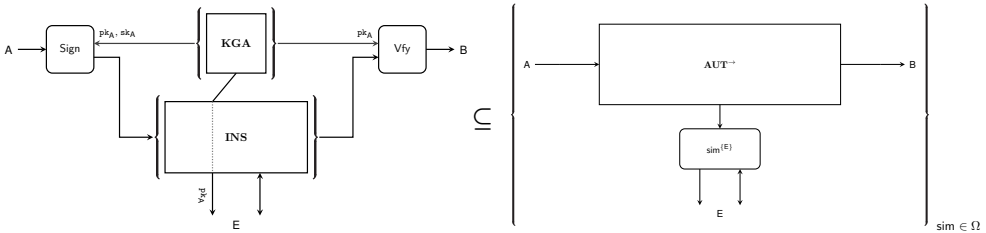

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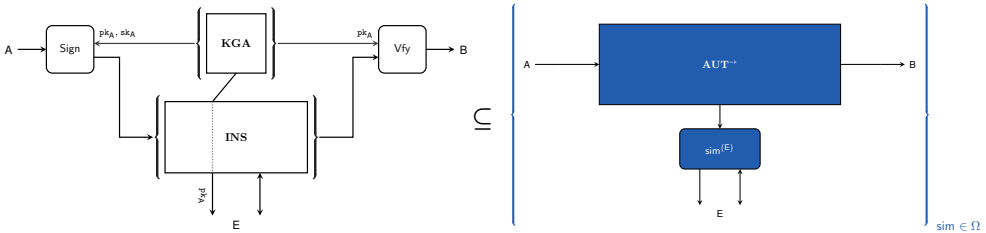

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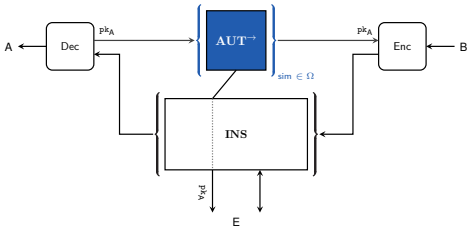

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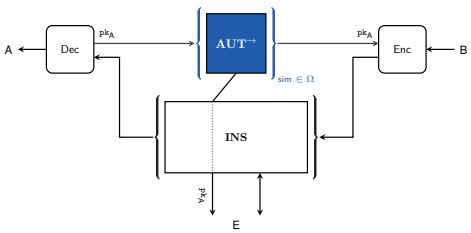

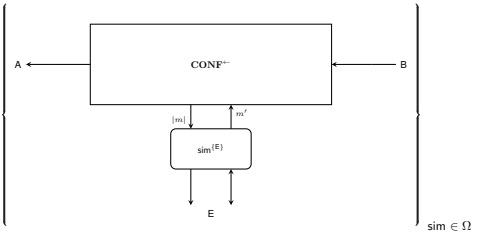

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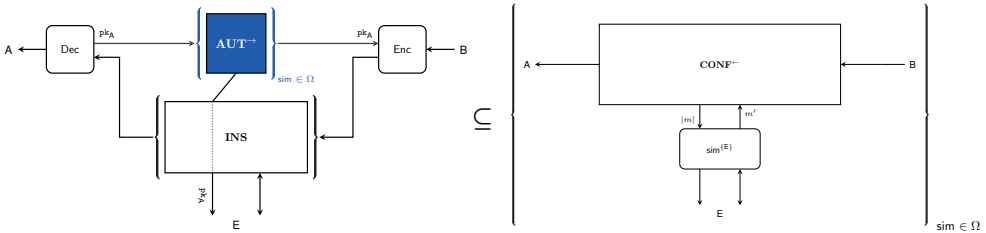

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Outline

Repositories — An abstract model for communication

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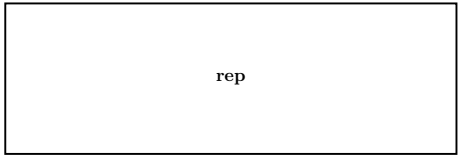
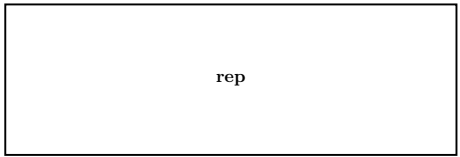


Repositories — An abstract model for communication

$\mathsf{A}_i \in \mathcal{W}$



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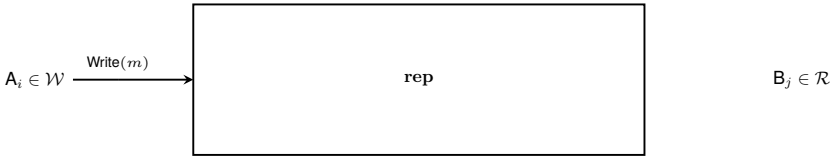

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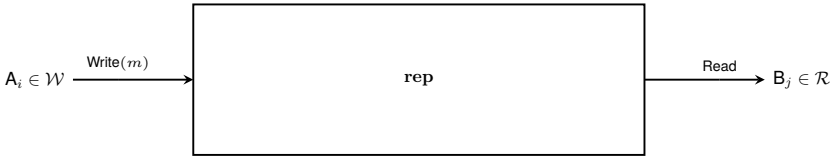

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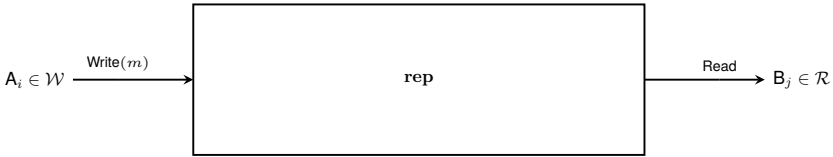

$\mathsf{C}_k \in \mathcal{C}$

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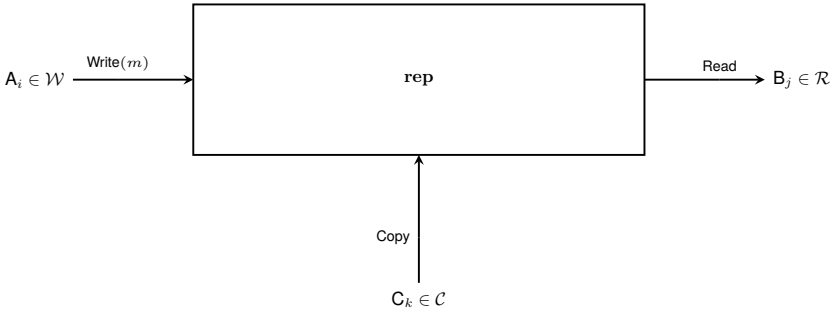

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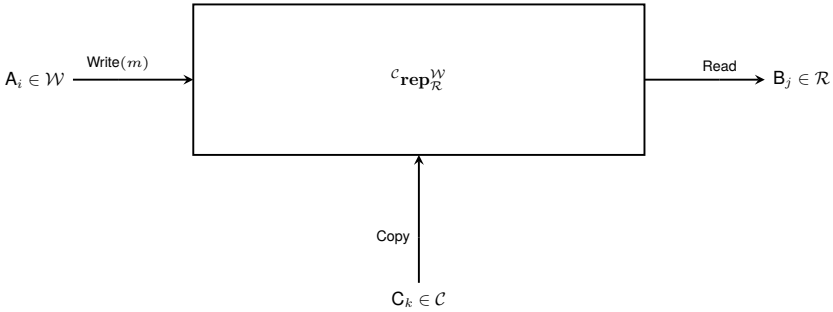

Outline

Composable Notions for MDVS

Composable Notions for MDVS — Notation

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Set of parties: $\mathcal{P}$

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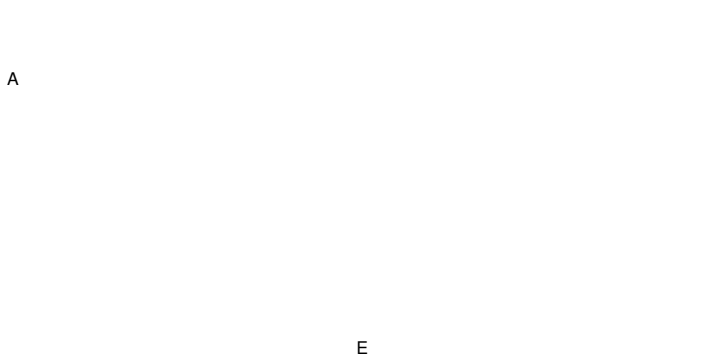

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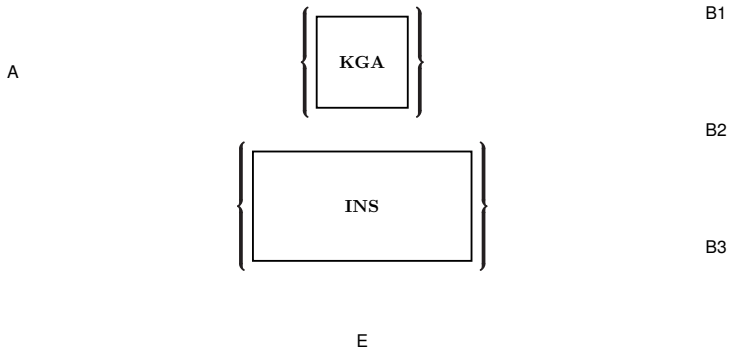

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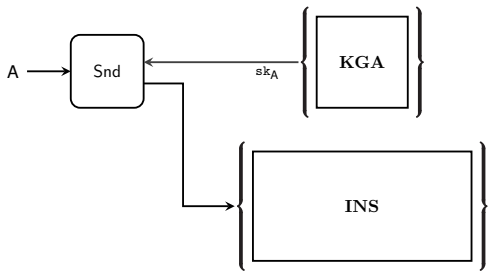

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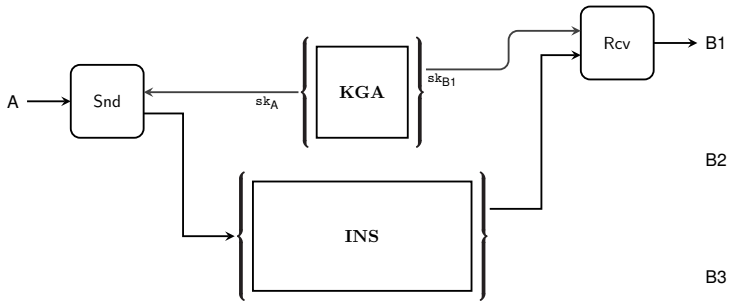

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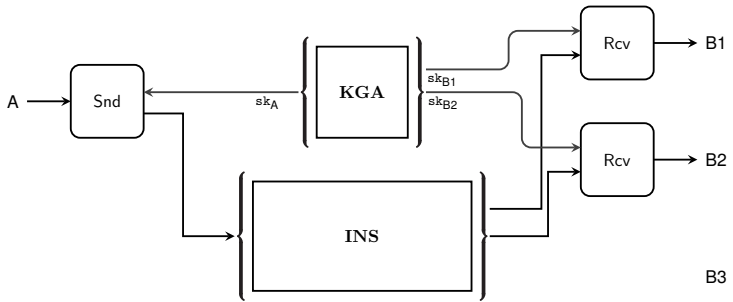

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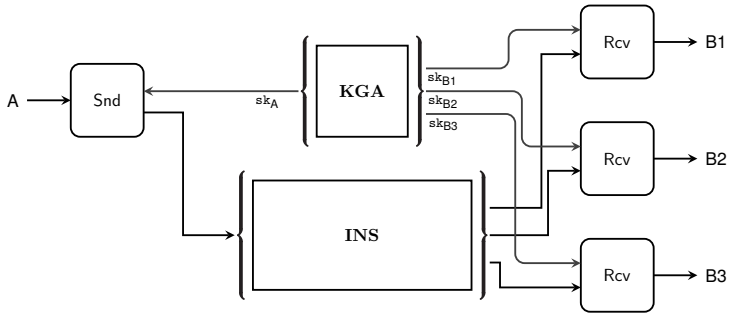

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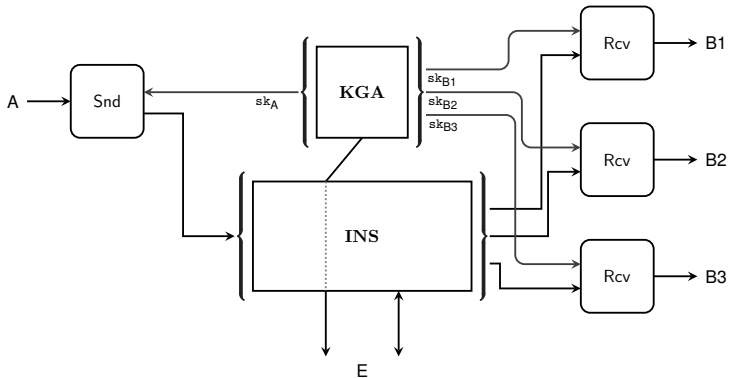

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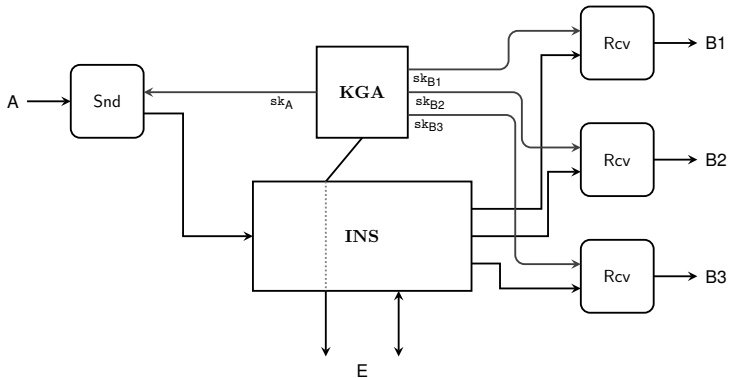

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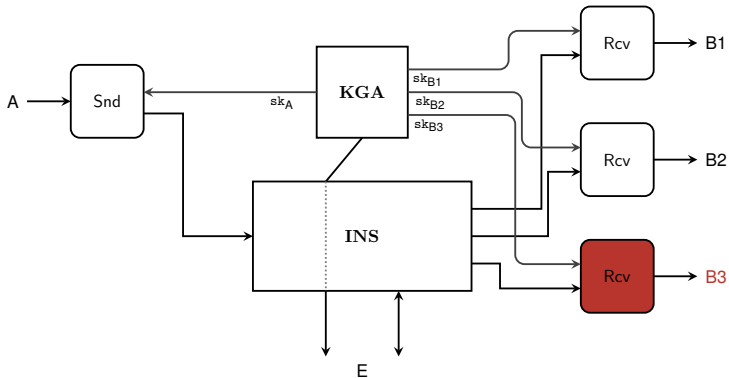

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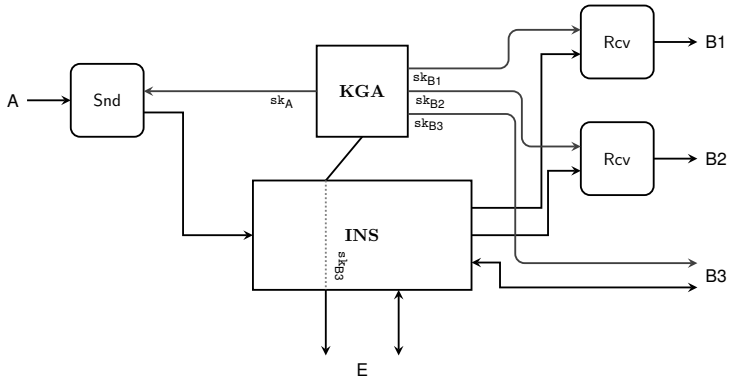

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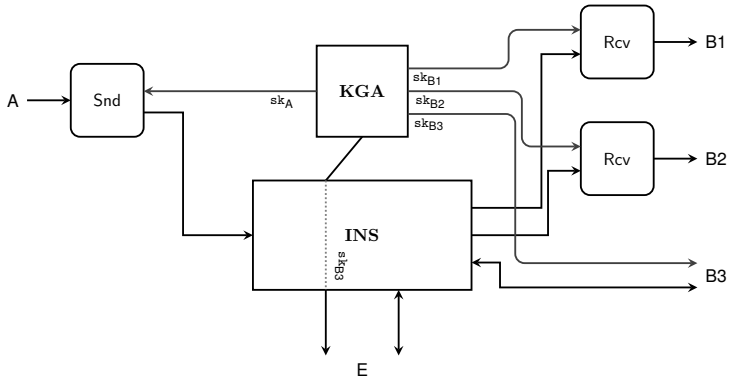
$\boldsymbol{\mathcal{R}}$ denotes the real world specification.



Composable Notions for MDVS — Correctness and Authenticity

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B1

A

B2

B3

E

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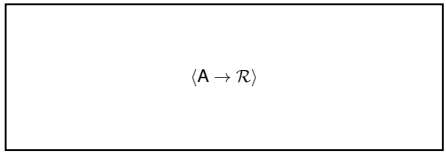

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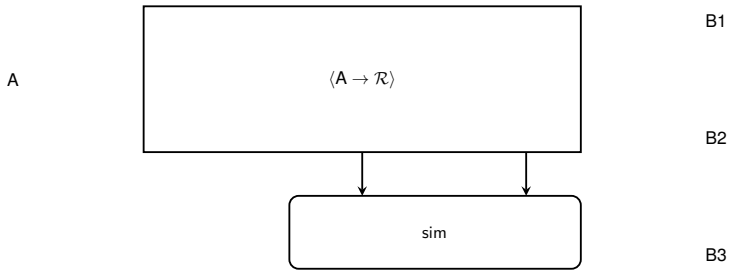

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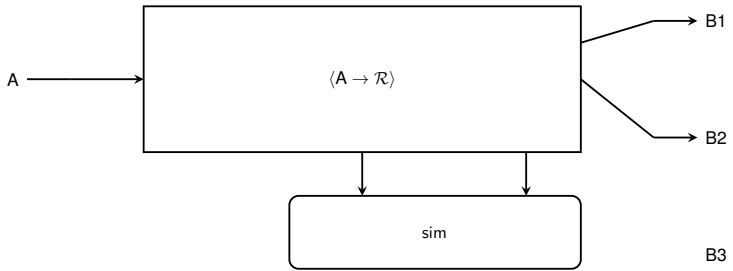

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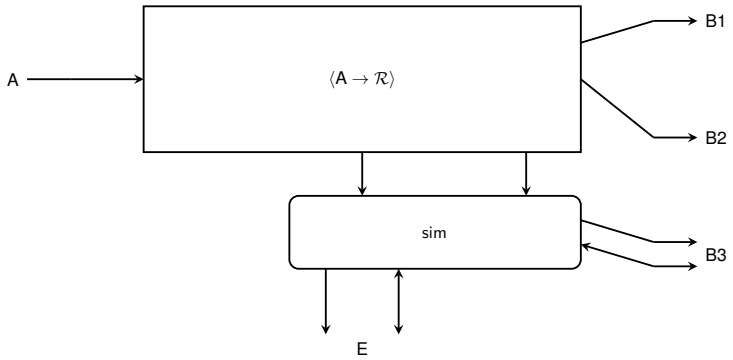

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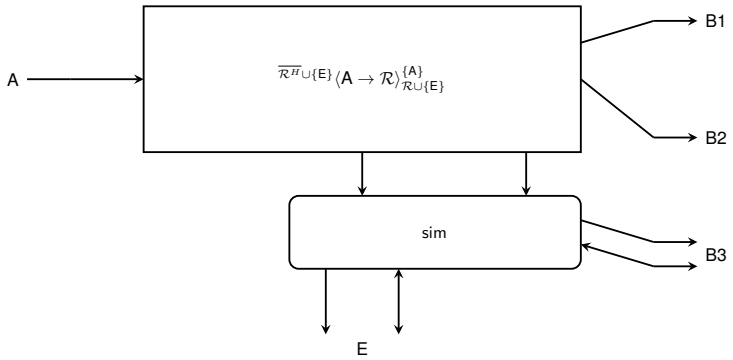

Composable Notions for MDVS — Correctness and Authenticity

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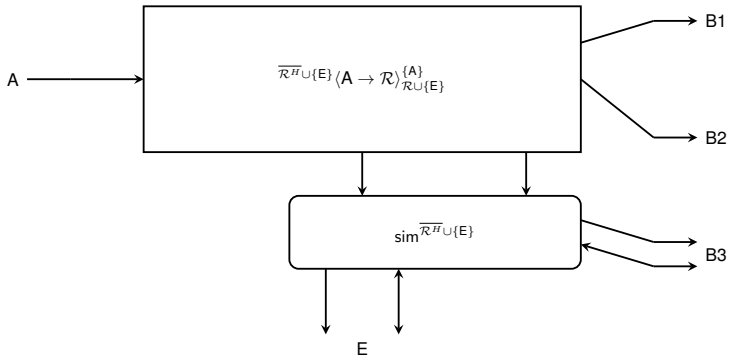

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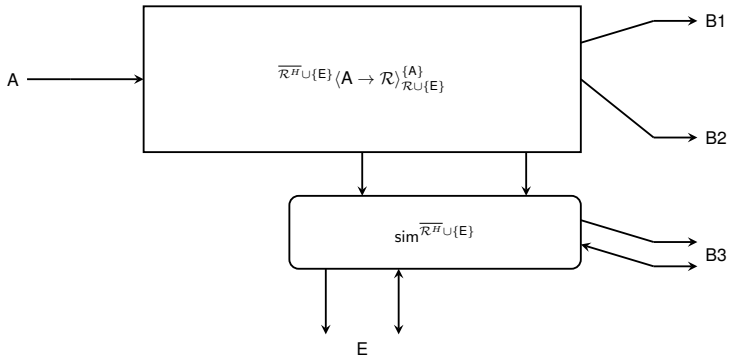
$\boldsymbol{\mathcal{A}}$ denotes the specification capturing Correctness and Authenticity.



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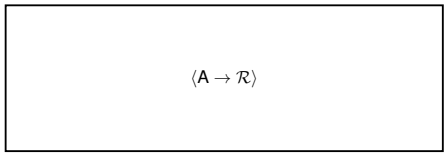

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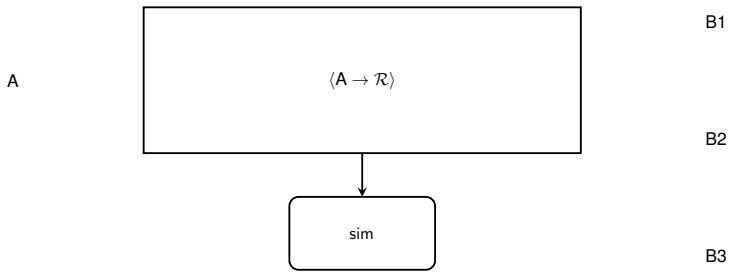

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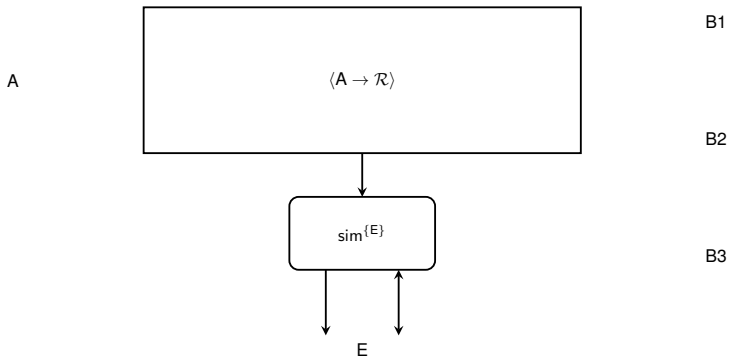

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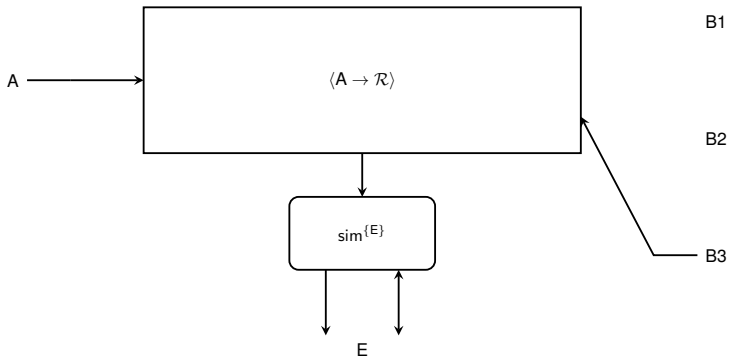

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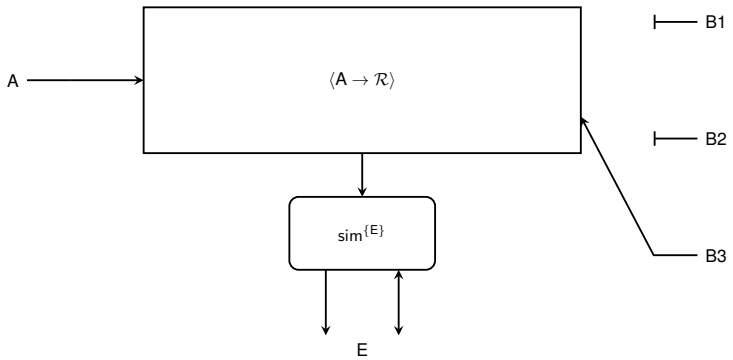

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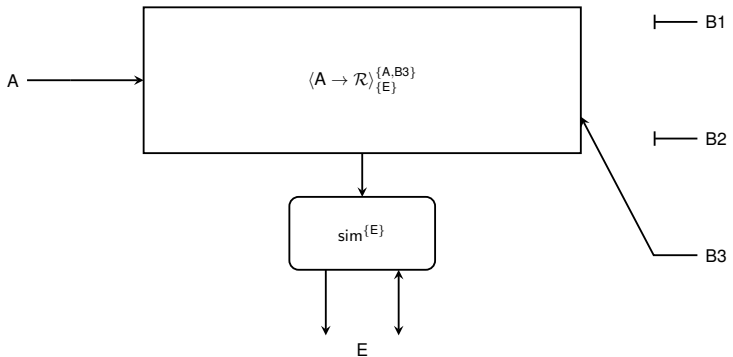

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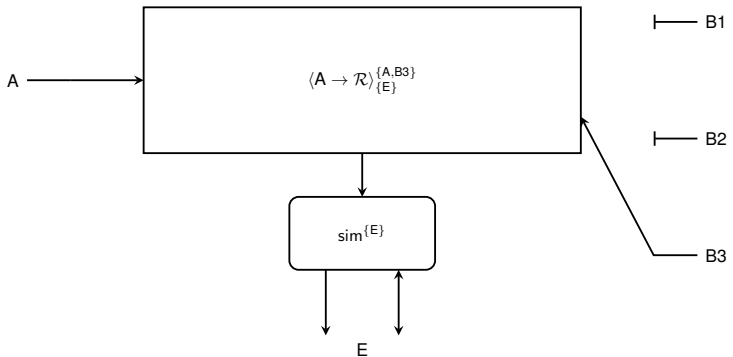

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Make a statement about what B3 **can do**!

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Make a statement about what B3 **can do**!

B3 **can run** a protocol π to simulate Alice writing!

Composable Notions for MDVS — B3 could have written

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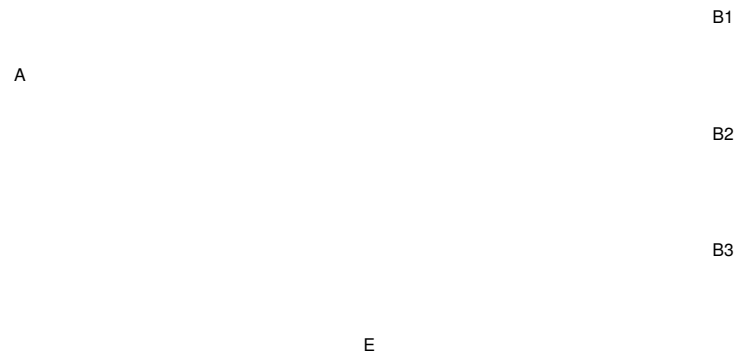

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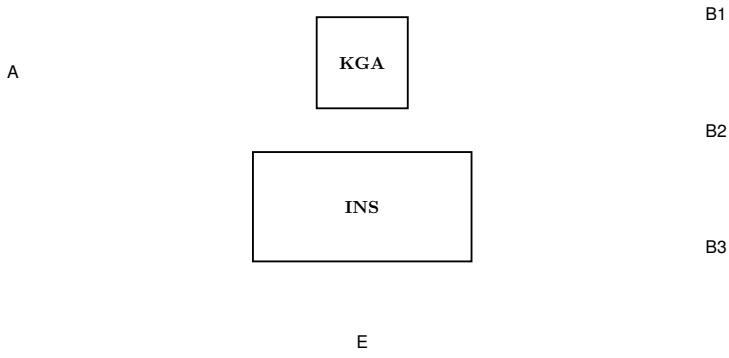

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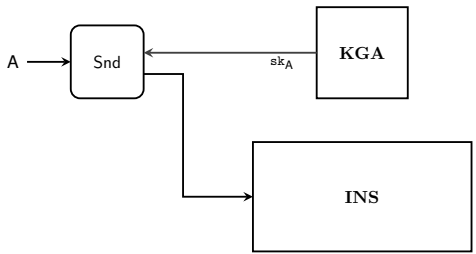

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B2

B3

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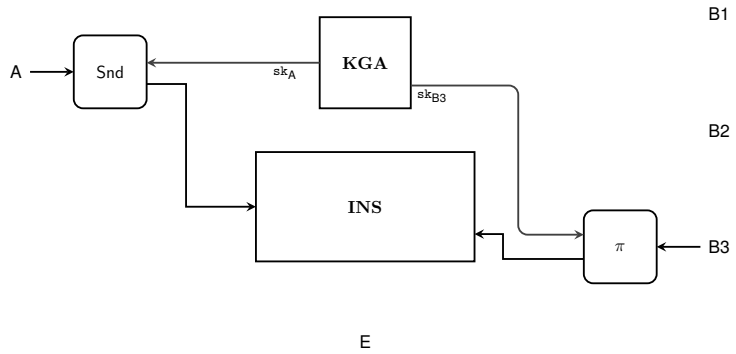

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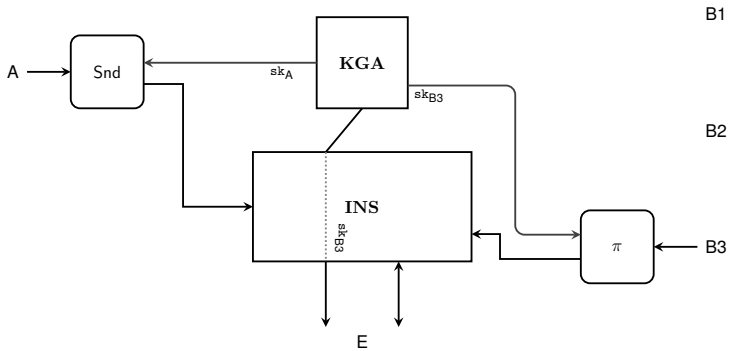

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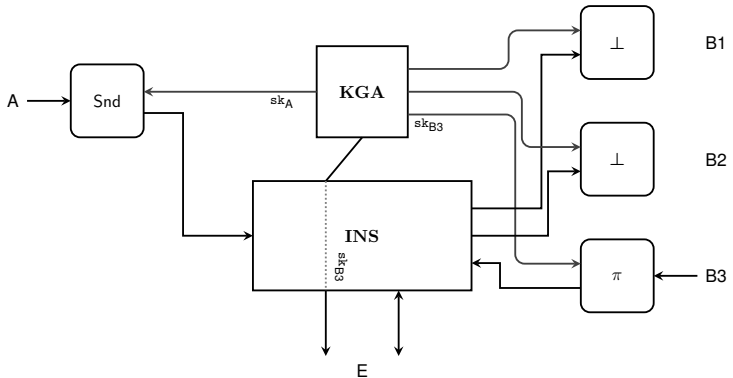

Composable Notions for MDVS — Capturing the ideal specification

Specification capturing guarantee that dishonest receivers **can write:**

$$\widehat{\boldsymbol{\mathcal{X}}} \coloneqq \left\{ \mathsf{sim}^{\{E\}} \left[\langle A \to \mathcal{R} \rangle_{\{E\}}^{\{A\} \cup \overline{\mathcal{R}^H}} \right] \right\}_{\mathsf{sim} \in \Omega}$$

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$$\boldsymbol{\mathcal{X}}_\pi := \left\{ \mathbf{R} \mid \pi^{\overline{\mathcal{R}^H}} \perp^{\mathcal{R}^H} \mathbf{R} \in \widehat{\boldsymbol{\mathcal{X}}} \right\}$$

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Construction statement: $\mathcal{R} \subseteq \mathcal{A} \cap \mathcal{X}_\pi$.

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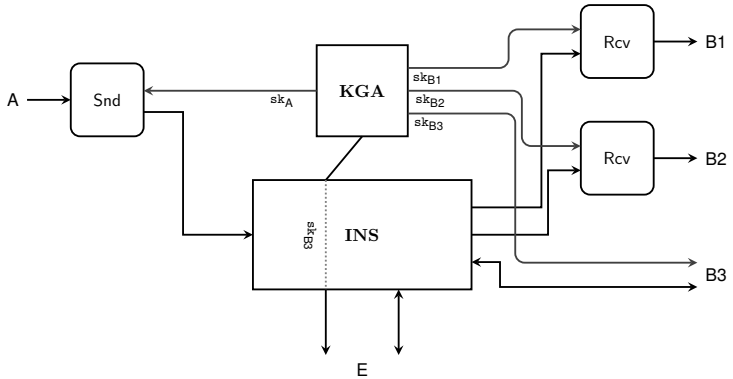

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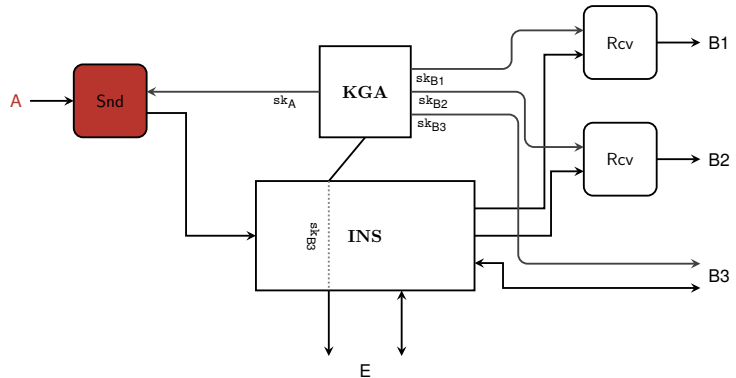

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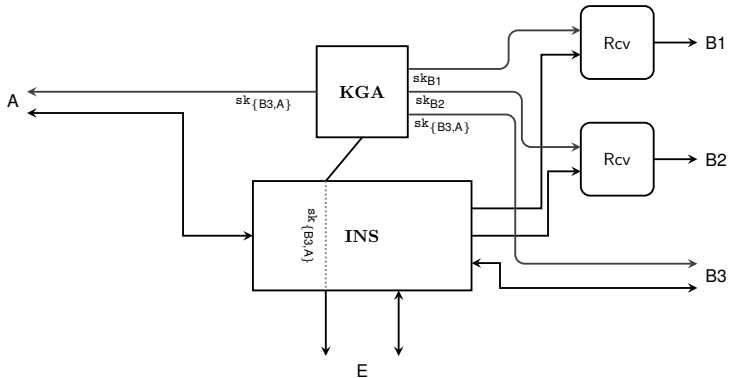

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If an honest receiver gets a message m, all honest receivers get m too.

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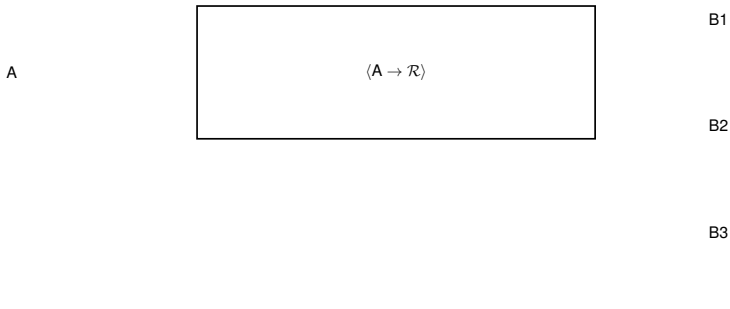

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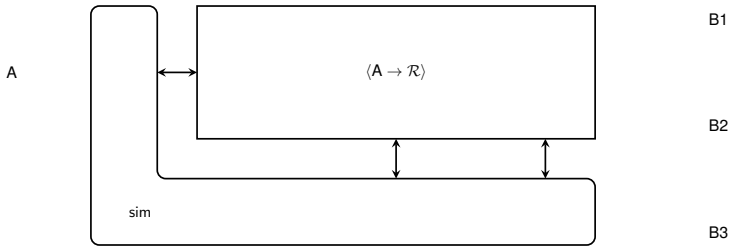

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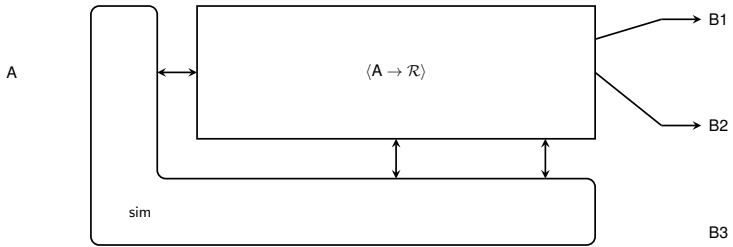

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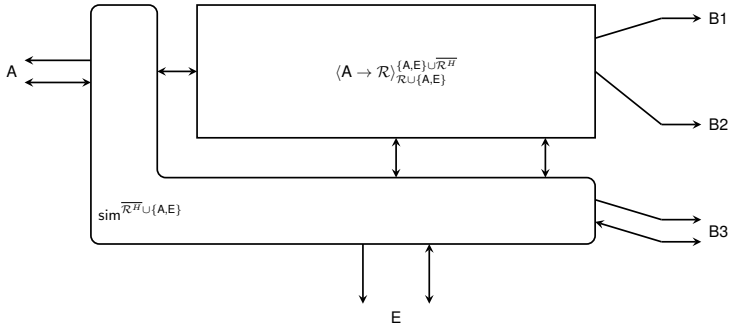

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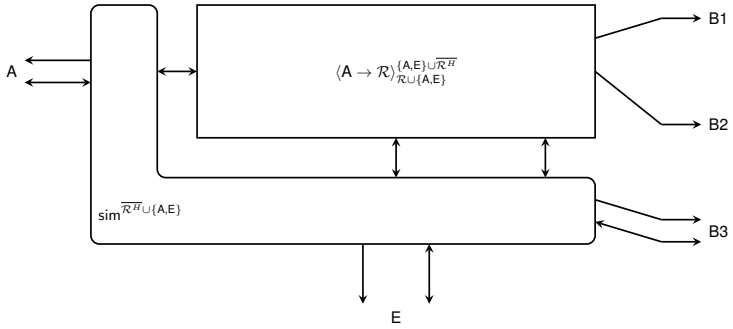

Outline

1. Introduction
2. Constructive Cryptography
3. Repositories
4. Composable Notions
5. Other Contributions
6. Thank You!

Further Composable Notions for MDVS

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Static corruptions: set of dishonest parties is fixed.

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Only the notions introduced by Damgård et al. [1] capture the security of MDVS in this arbitrary party setting;

Our notions for arbitrary party setting are strictly weaker than Damgård et al.'s.

Outline

Thank you!


Ivan Damgård, Helene Haagh, Rebekah Mercer, Anca Nitulescu, Claudio Orlandi, and Sophia Yakoubov.

Stronger security and constructions of multi-designated verifier signatures.

In Rafael Pass and Krzysztof Pietrzak, editors, *TCC 2020: 18th Theory of Cryptography Conference, Part II*, volume 12551 of *Lecture Notes in Computer Science*, pages 229–260, Durham, NC, USA, November 16–19, 2020. Springer, Heidelberg, Germany.


Ueli Maurer and Renato Renner.

From indifferentiability to constructive cryptography (and back).

In Martin Hirt and Adam D. Smith, editors, *TCC 2016-B: 14th Theory of Cryptography Conference, Part I*, volume 9985 of *Lecture Notes in Computer Science*, pages 3–24, Beijing, China, October 31 – November 3, 2016. Springer, Heidelberg, Germany.