Policy-based signatures

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joint work with Mihir Bellare

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Overview

- New signature primitive
- Signer can only sign messages conforming to policy

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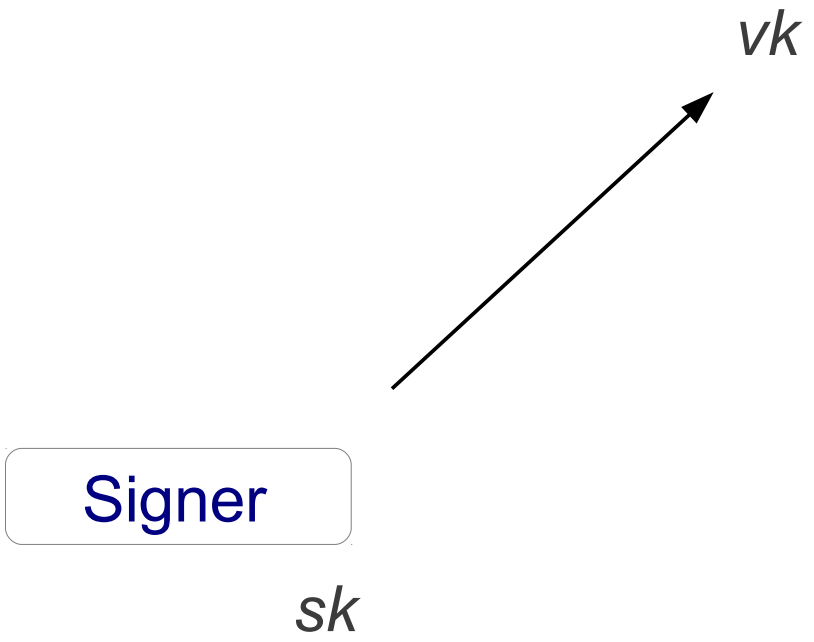
- Practical applications: use for corporations
- Theoretical: unification of existing work

Signatures



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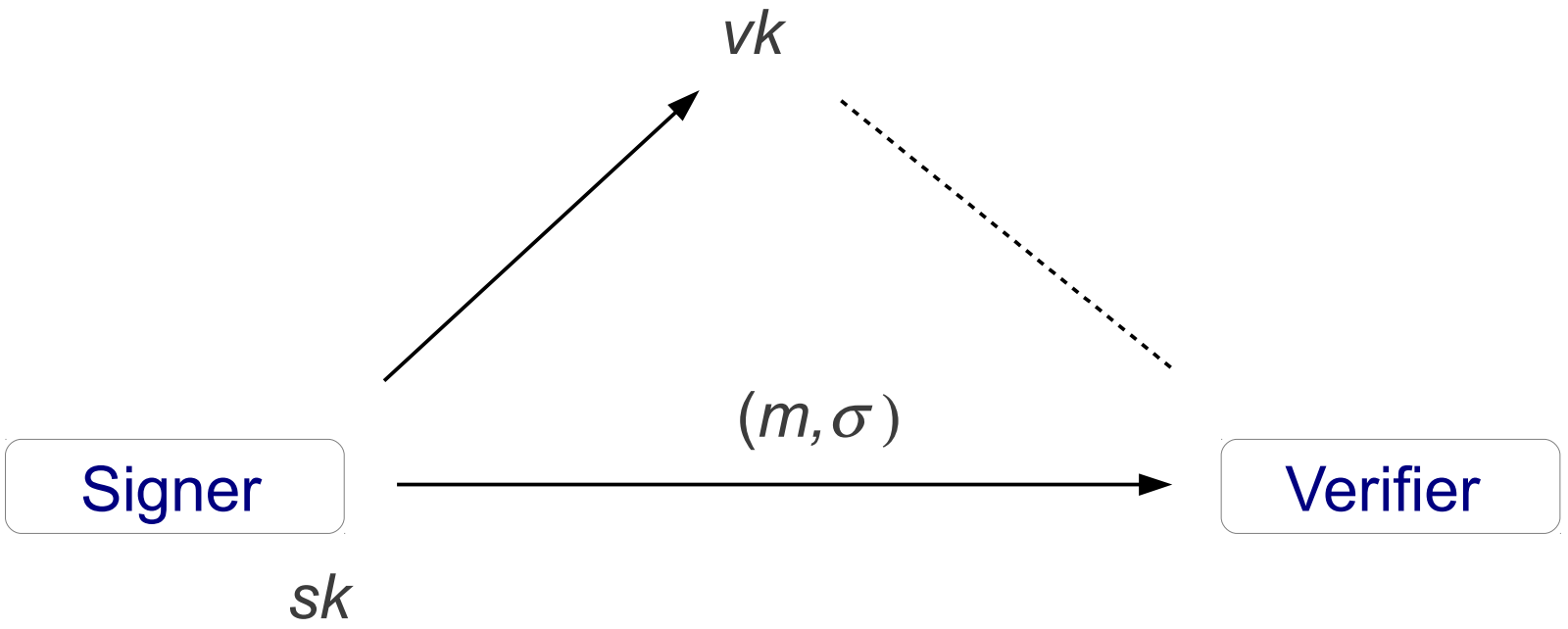
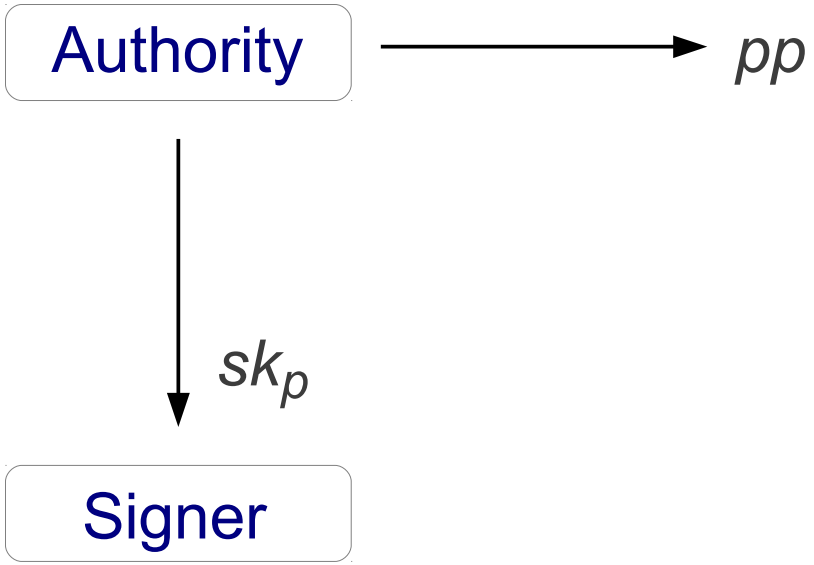


Policy-based signatures



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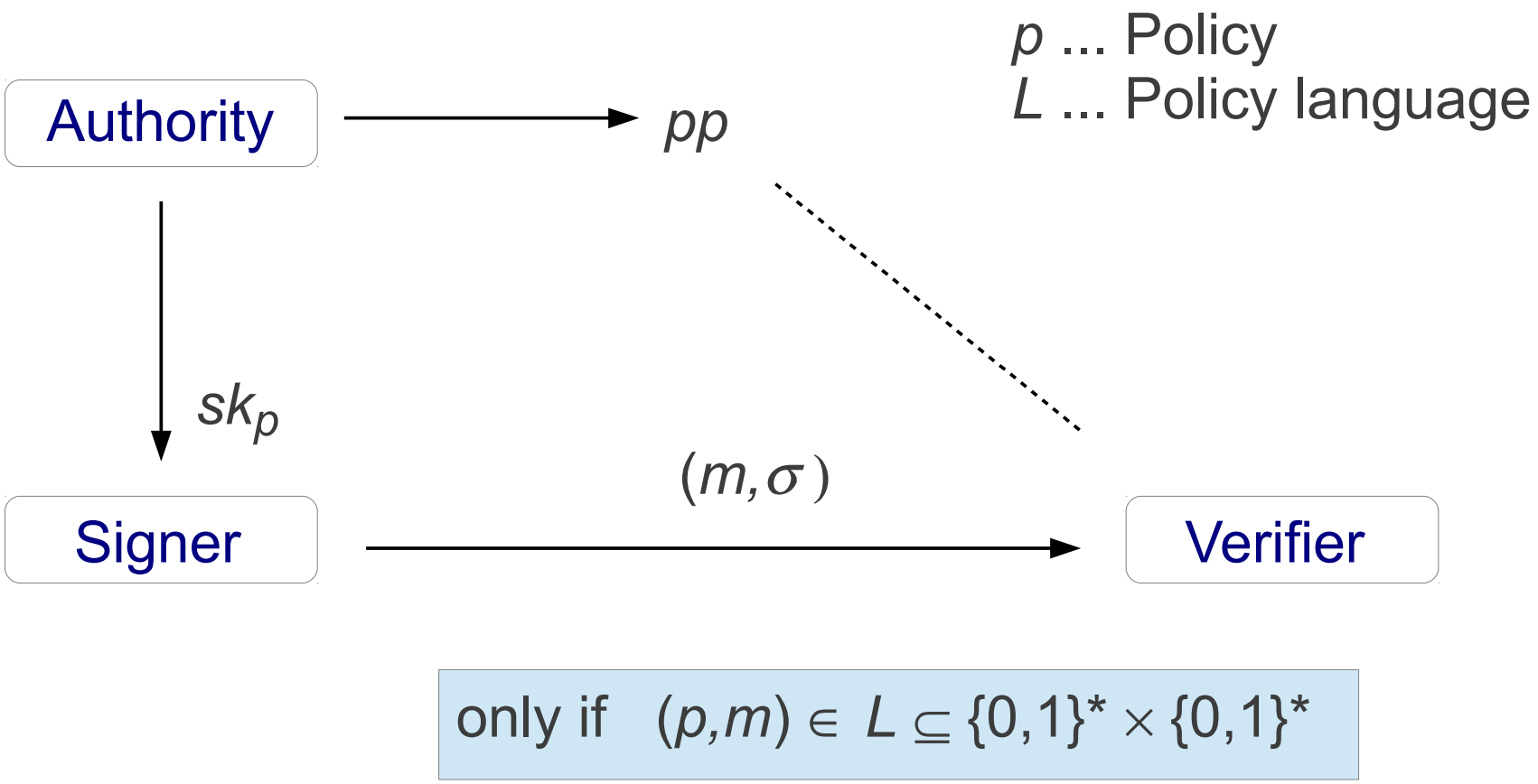

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  You can only sign a message *m* if you have a key for a policy *p* satisfied by *m*

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- Privacy:

  The signature does not reveal the policy

Theoretical Motivation

- Signature analog to functional encryption [BSW11]

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- Unification of existing notions for signatures with privacy:

  Group signatures [Cv91]

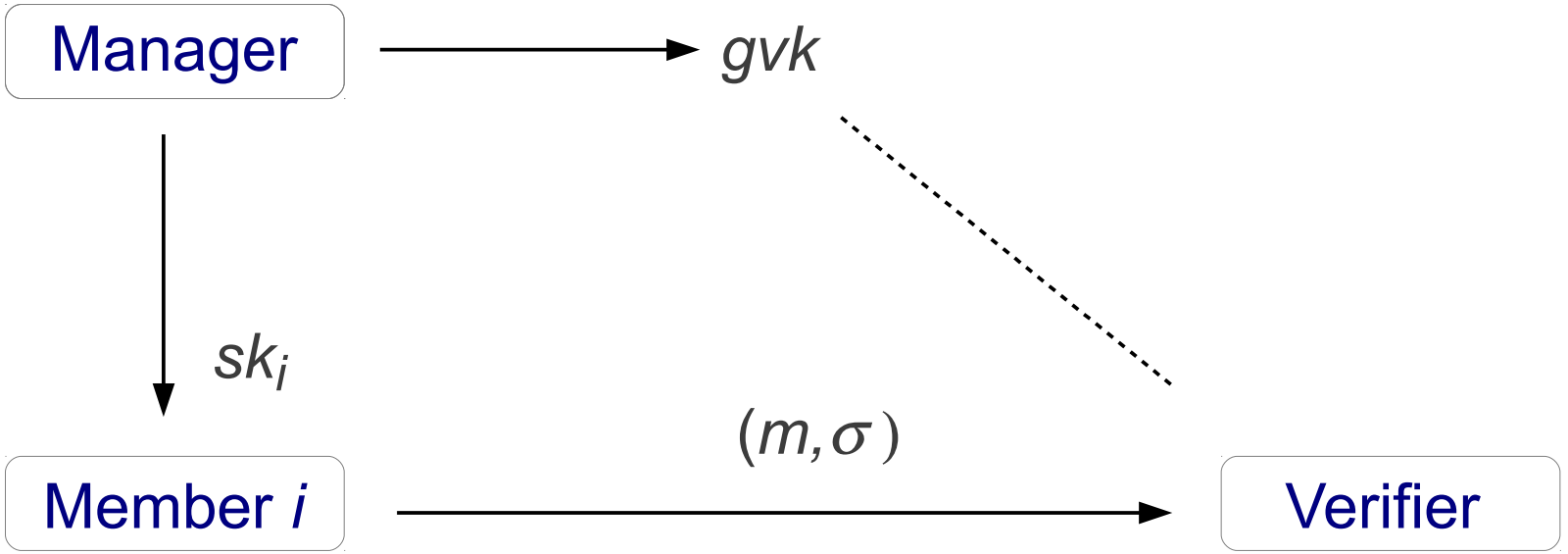
  (Anonymous) proxy signatures [MUO96,FP08]

  Ring signatures, mesh signatures [RST01,Boy07]

  Attribute-based signatures [MPR11]

  Anonymous credentials [CL01,BCKL08]

Group signatures



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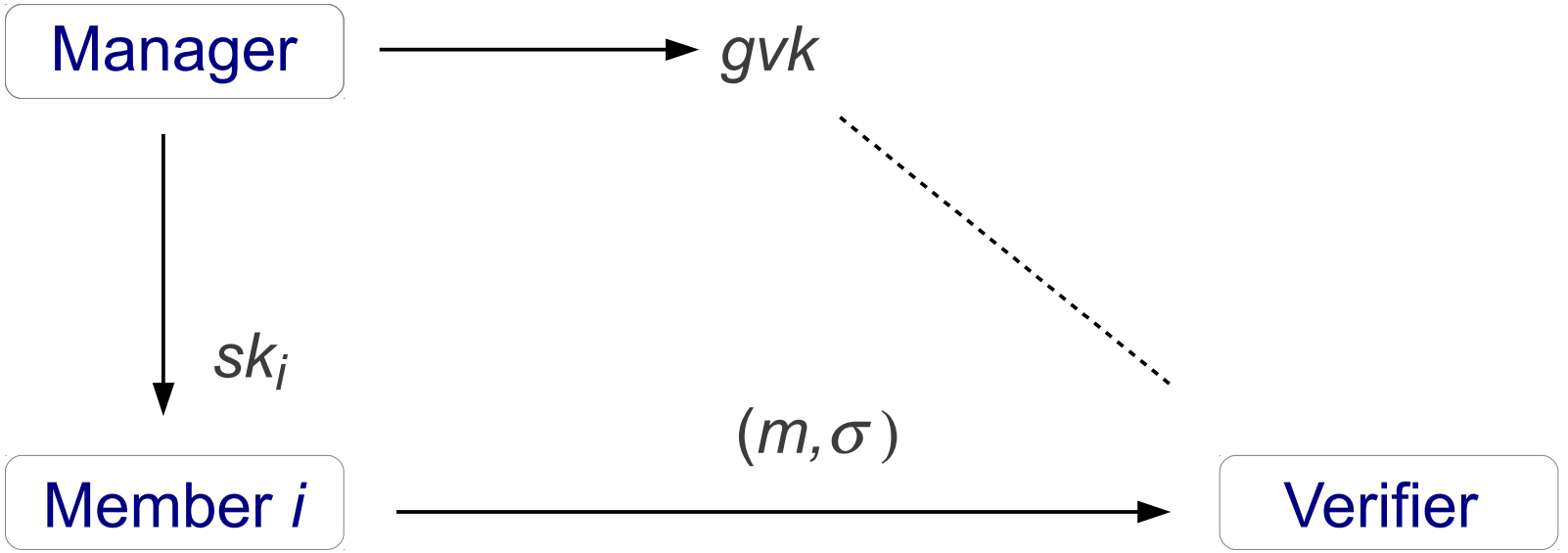
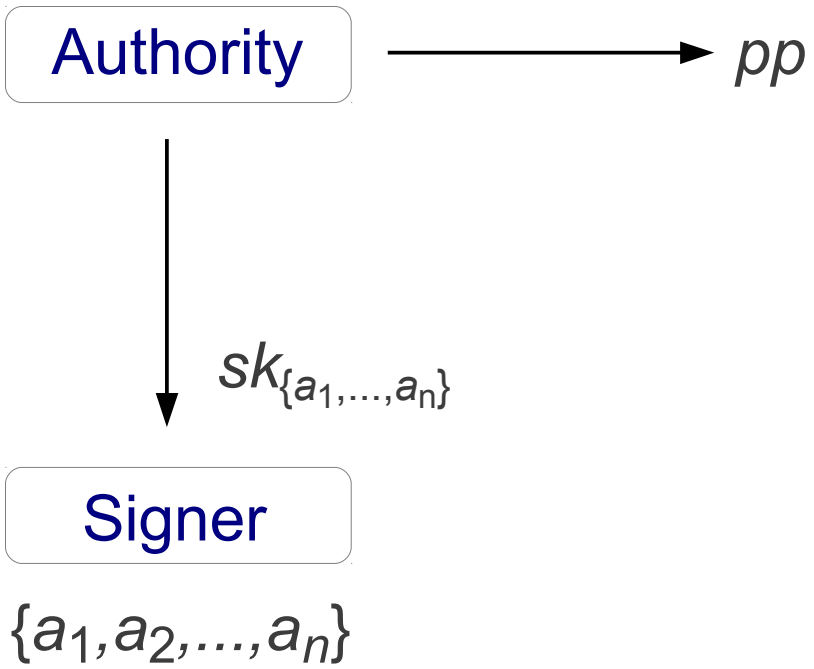


σ anonymous, but can be opened:

σ —Manager→ *i*

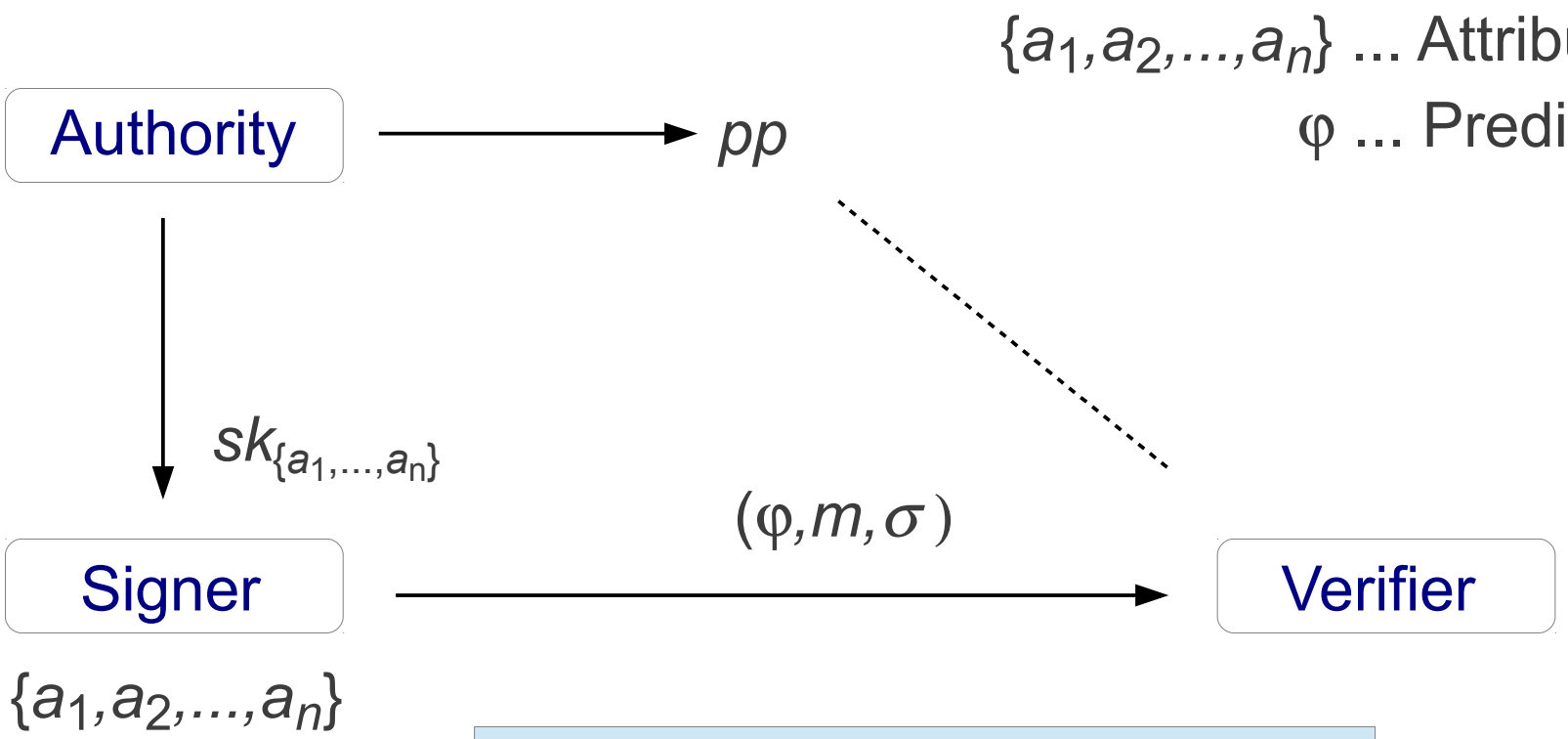
Attribute-based signatures



$\{a_1,a_2,...,a_n\}$ ... Attributes

φ ... Predicate

Attribute-based signatures



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- Company with public key *vk*
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Example:

Employee gets key with which she can sign contracts only with company *B.*

Definition of PBS

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- Policy languages:

  We allow any language in **NP**, defined by policy checker

  $$\mathrm{PC} : ((p,m),w) \rightarrow \{0,1\}$$

  $$(p,m) \in L(\mathrm{PC}) \;:\Leftrightarrow\; \exists\, w \in \{0,1\}^* : \mathrm{PC}((p,m),w) = 1$$

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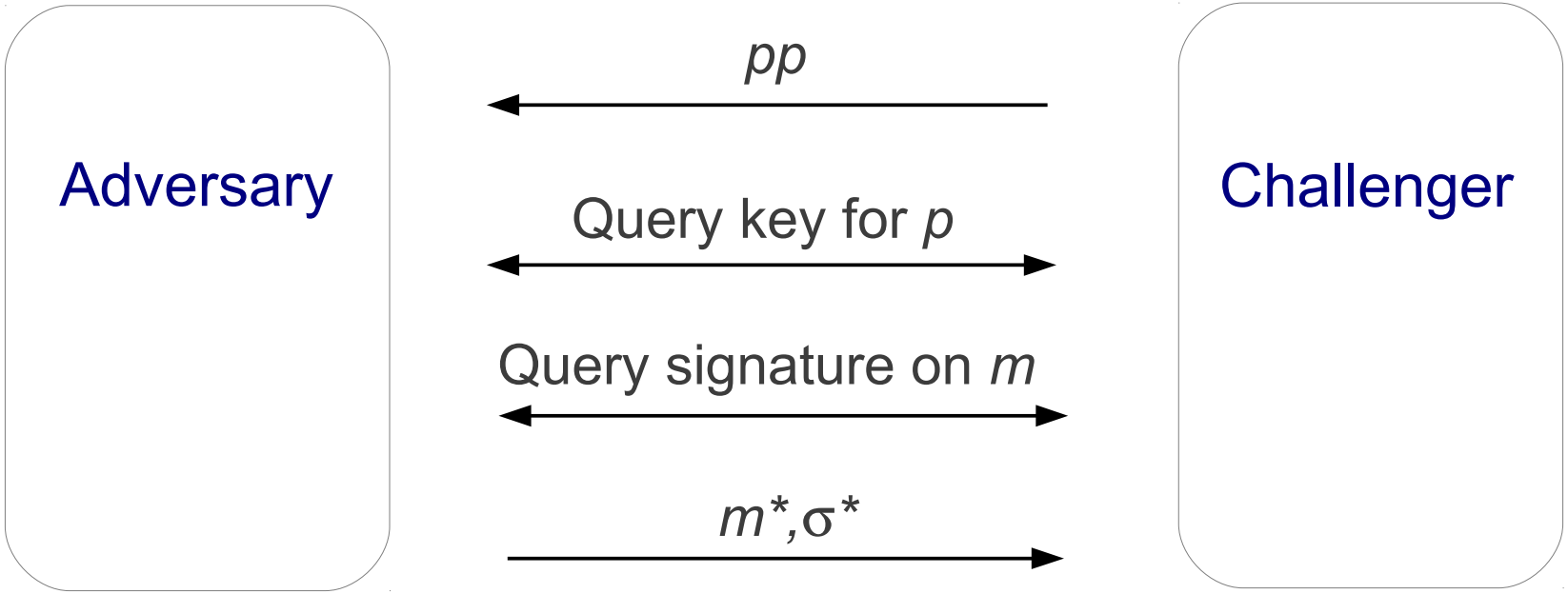
- Algorithms:

$$\begin{aligned} \mathrm{Setup}(1^\lambda) &\rightarrow (pp,msk) \\ \mathrm{KeyGen}(msk,p) &\rightarrow sk_p \\ \mathrm{Sign}(sk_p,m,w) &\rightarrow \sigma \\ \mathrm{Verify}(pp,m,\sigma) &\rightarrow b \end{aligned}$$

Unforgeability

- Game



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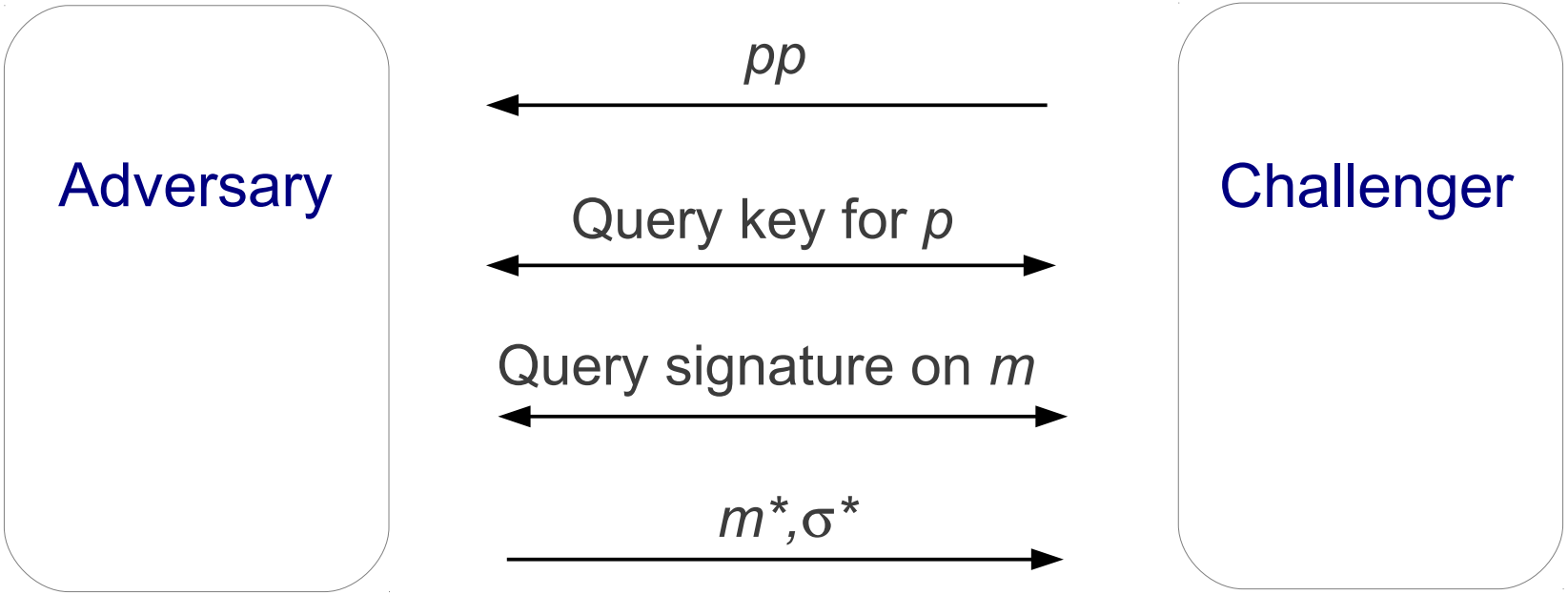

A wins if - Verify(*pp*,*m**,σ*) = 1,
- no signature query for *m**,
- for all key queries for *p*: $(p, m^*) \notin L(\mathrm{PC})$

Indistinguishability

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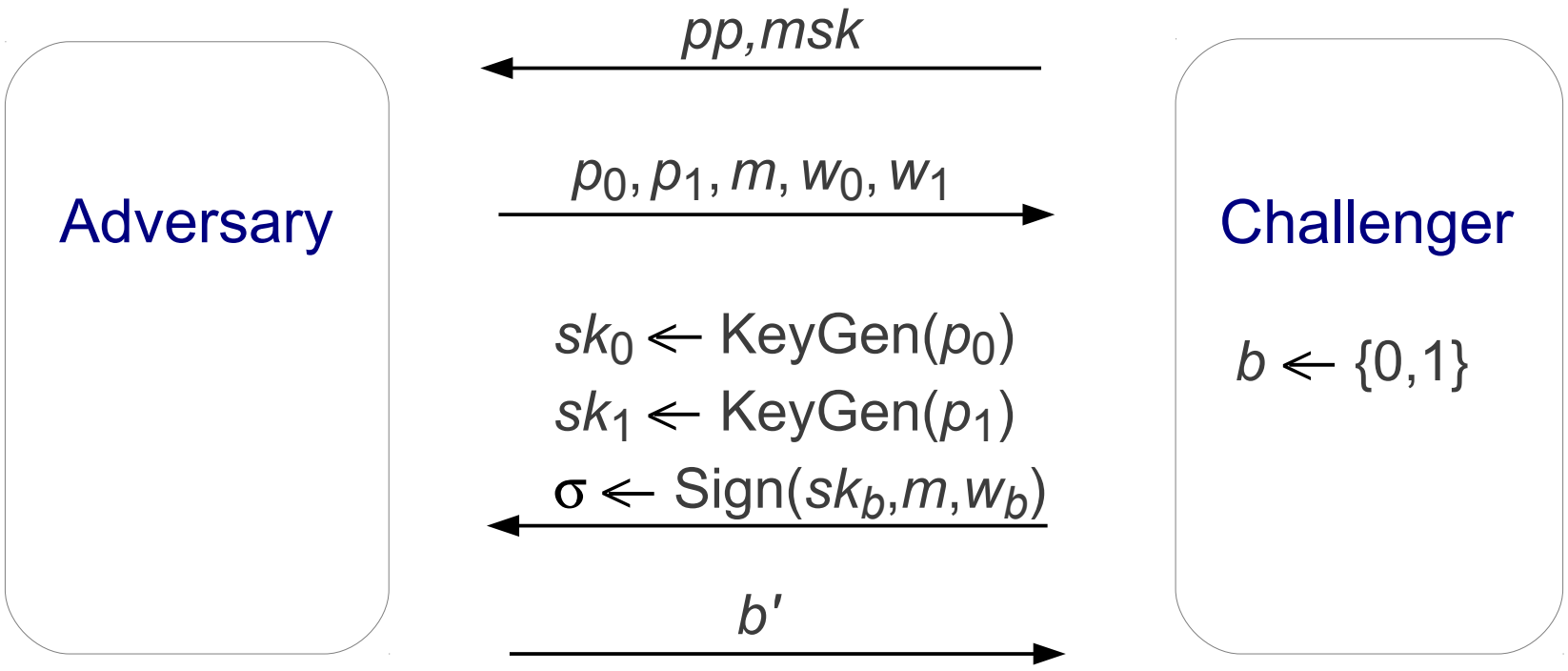

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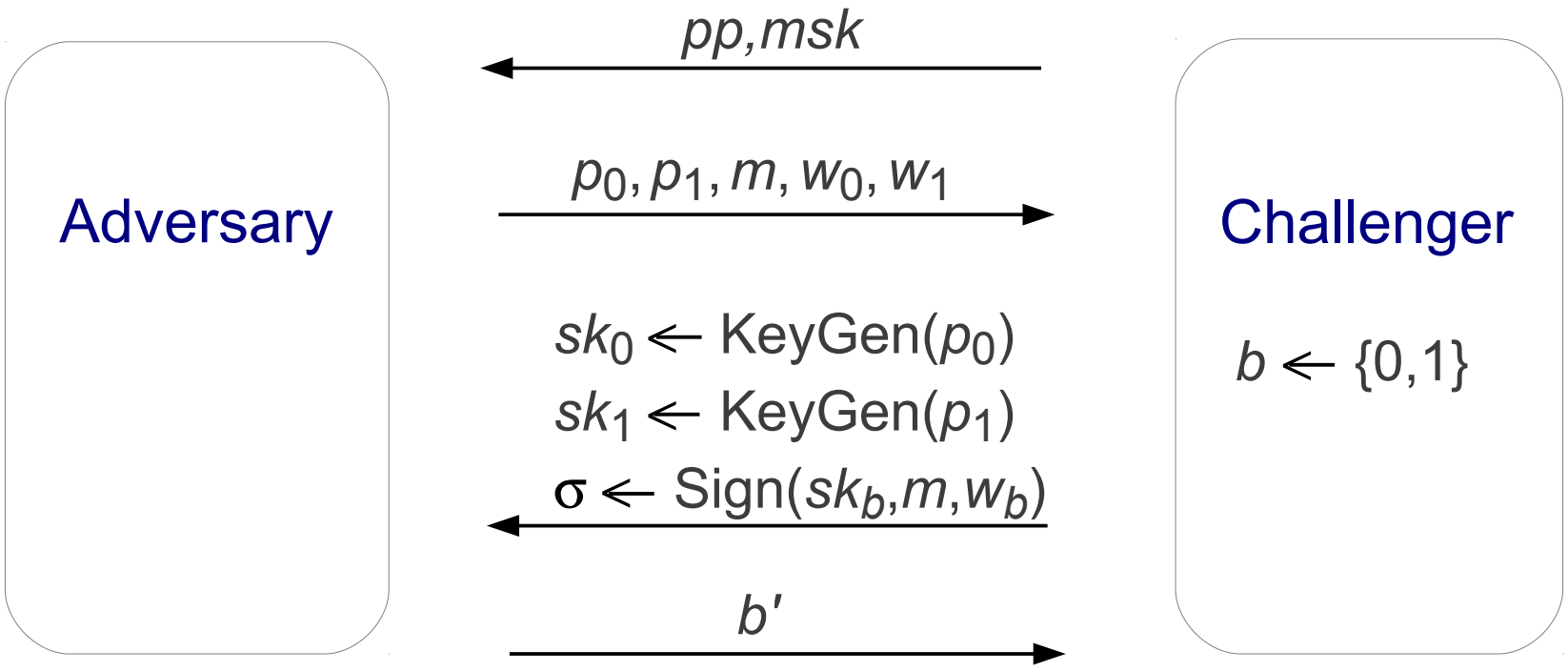

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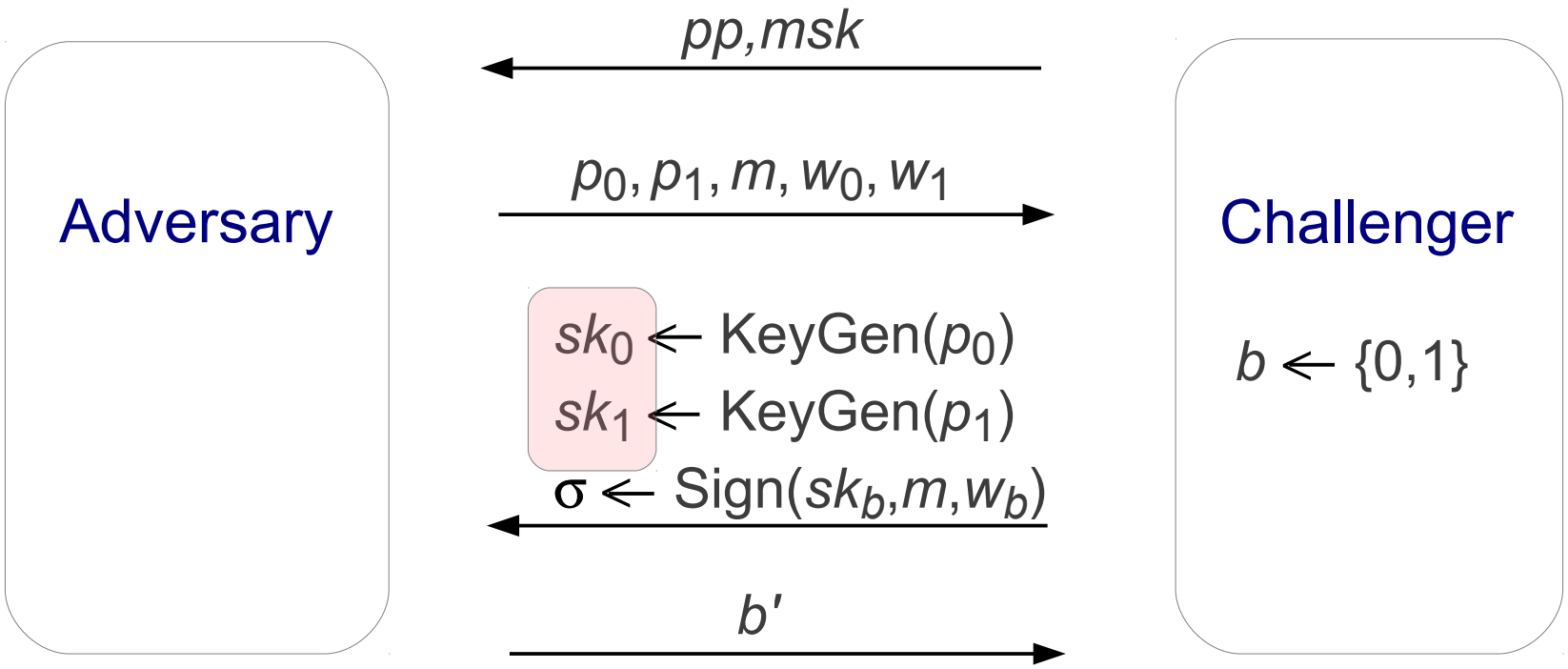

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  $\Rightarrow$ Extraction-based definition

Extr+Sim $\Rightarrow$ UF+IND

Constructions of PBS

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- Efficient construction

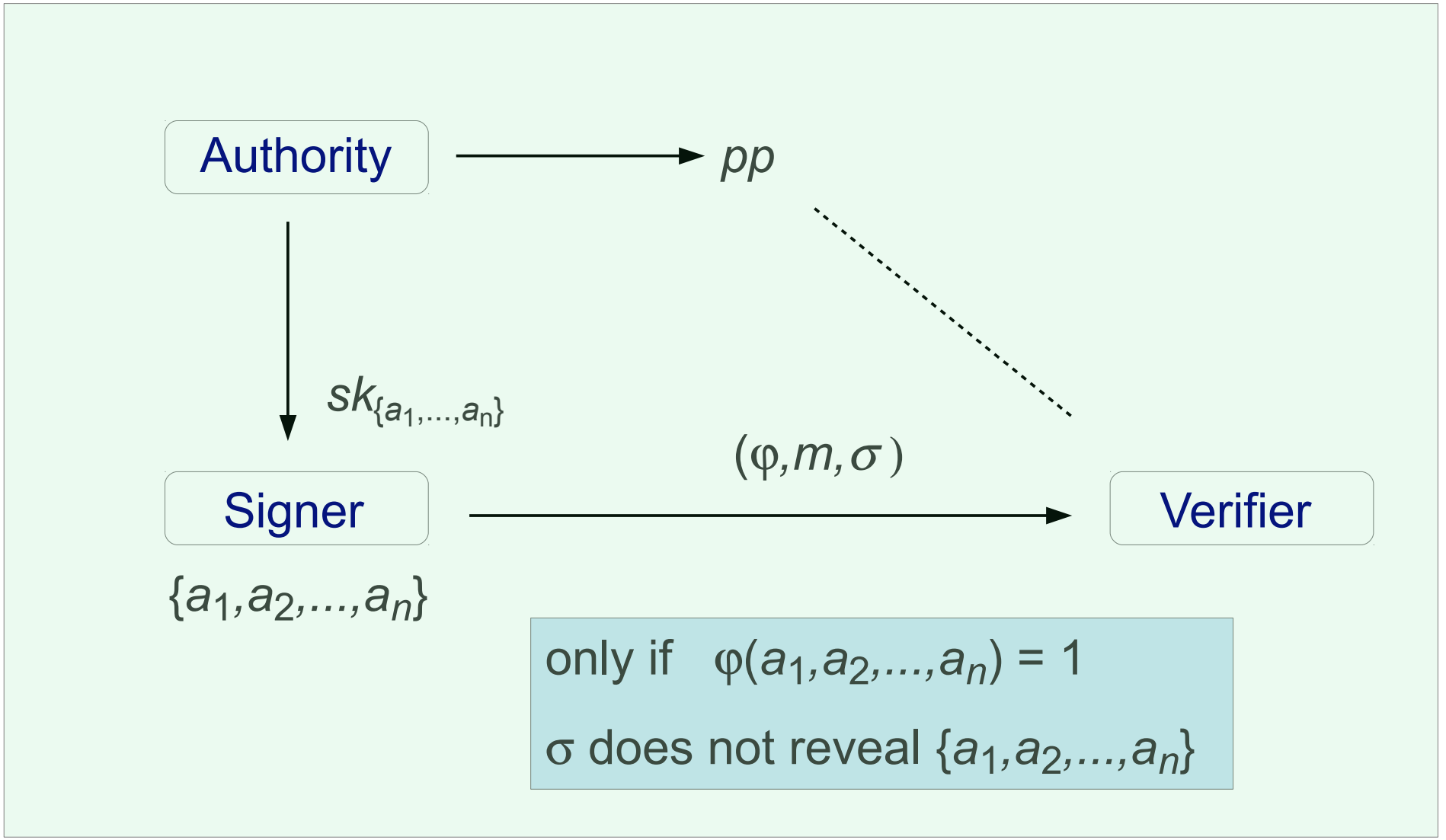
  based on - structure-preserving signatures [AFG+10]
  - Groth-Sahai proofs [GS08]

  for policy languages over **pairing groups**

  (policies define pairing-product equations)

Primitives from PBS

Attribute-based signatures from PBS



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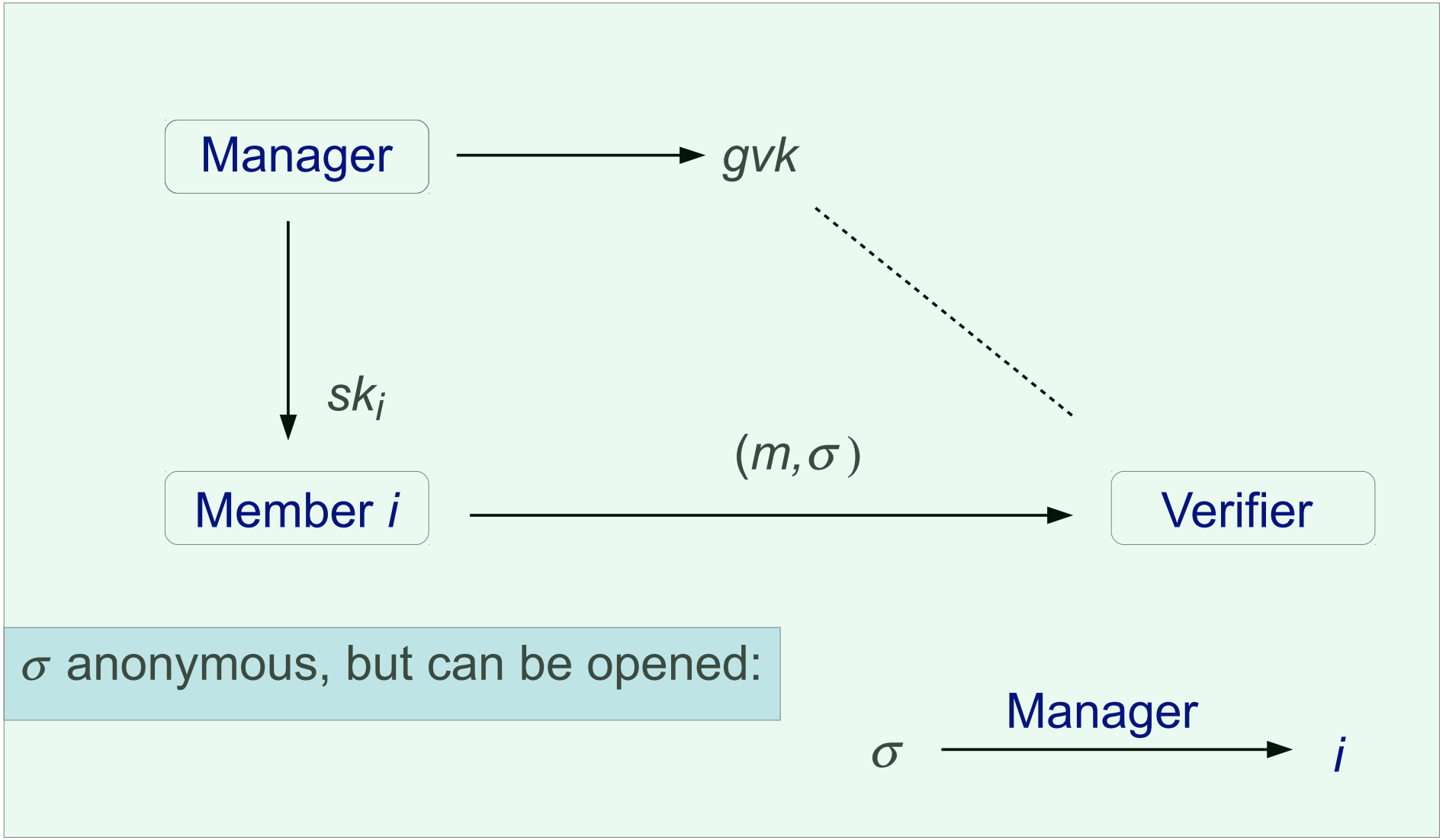

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Verify: verify PBS Open(dk,(c,σ)): decrypt c

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- Signatures of knowledge [CL06]

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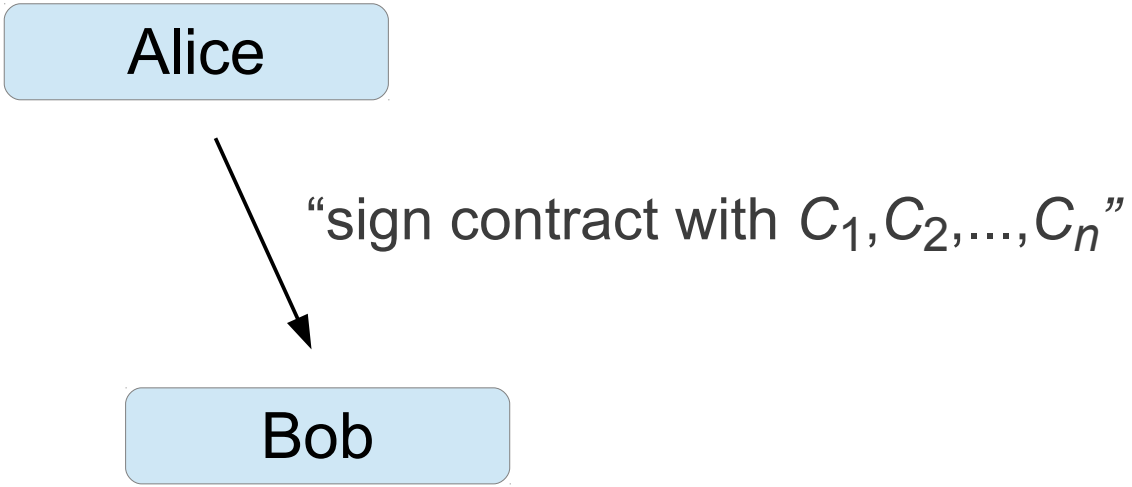

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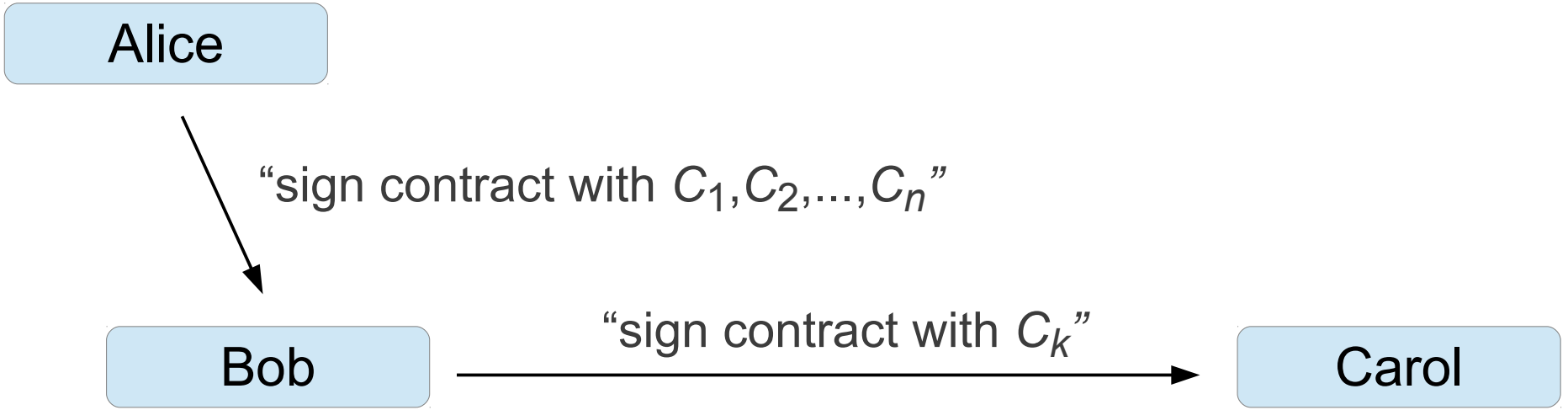

Thank you

PBS from SSE-NIZK

- Simulation-sound extractable NIZK:

  - prove membership for **NP** languages

- Authority has signature key pair (vk,sk)
- sk_p is signature on p
- PBS-signature on m is SSE-NIZK proof that $(vk,m) \in L$ defined by

$$((vk,m),(p,sig,w)) \in R_L \quad \Leftrightarrow$$

$$((p,m),w) \in \mathrm{PC} \wedge \mathrm{Verify}(vk,p,sig) = 1$$