Pairing-Free Blind Signatures from Standard Assumptions in the ROM

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[2] DIENS, École normale supérieure, CNRS, PSL University, Paris, France
[3] Department of Computer Science, ETH Zurich, Switzerland - *Work done partially while at ENS and Inria, Paris*

Motivations & Contributions

Round-optimal schemes [*see our paper for extensive ref's*]

- Generic and inefficient, or
- need pairings or lattices, or
- rely on interactive assumptions (+ ROM).

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Can we have efficient round-optimal blind signatures in ROM, from non-interactive assumptions, w/out pairings nor lattices?

Motivations & Contributions

Round-Optimal Blind Signatures Against Malicious Signers from DDH & sRSA

Motivations & Contributions

Relaxed
Range
Proofs w/
Subversion-ZK

Round-Optimal Blind Signatures Against Malicious Signers from DDH & sRSA

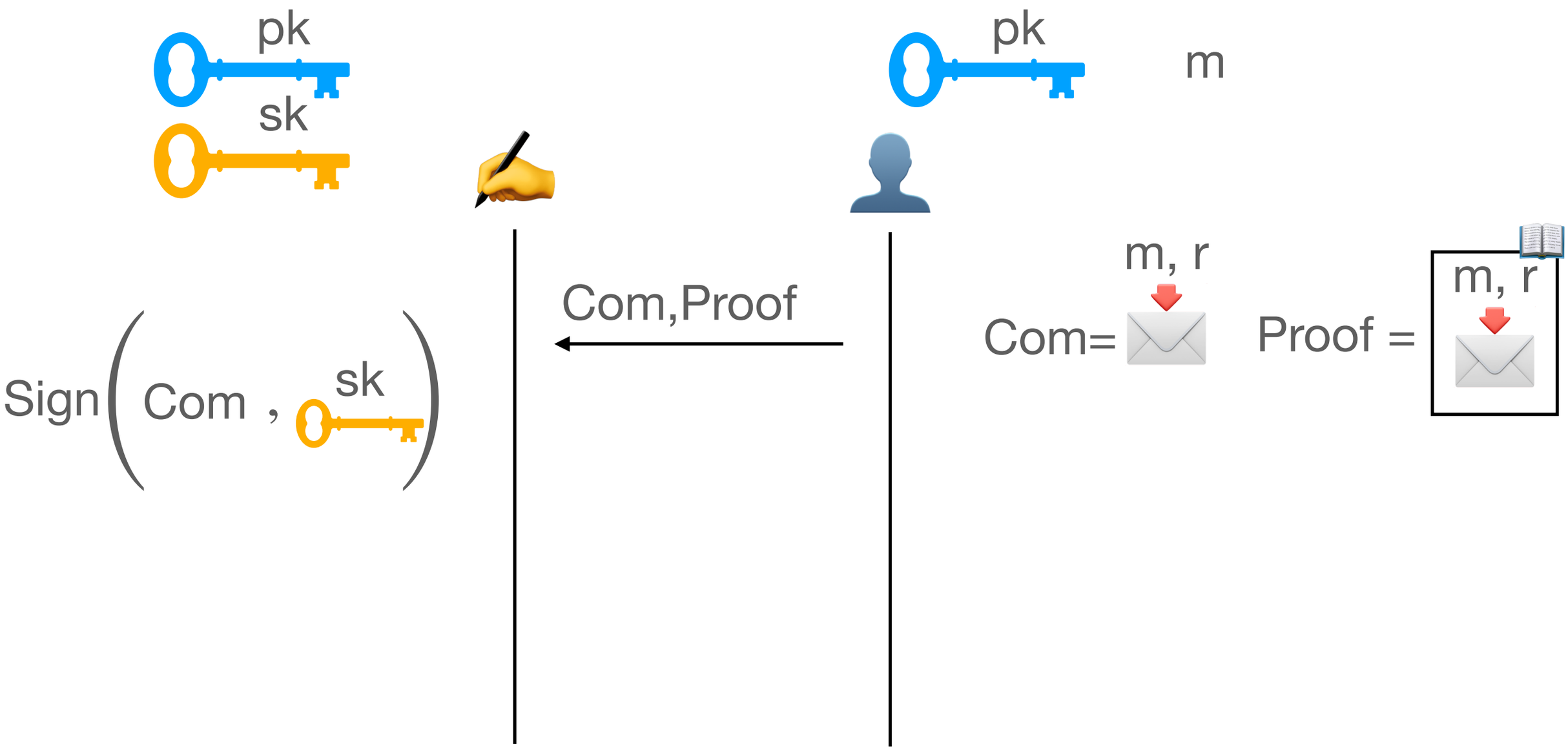
Compact
Commitments
In Arbitrary
Groups

Differences from Previous Talk

	Our work	Previous Talk
Setting	Hidden-Order & Prime-order Pairing-free Groups	Prime-order Pairing-free Groups
Goal	Efficient, Round-optimal, from standard non-interactive assumptions in ROM	In ROM w/out AGM nor GGM
Starting point	Fischlin Framework	Blind Schnorr & Blind BLS
Main challenges	Blindness against malicious signers, efficiency	Concurrent one-more unforgeability

Recall: Fischlin Framework (1)

[Fischlin06, Katsumata-Reichle-Sakai23]



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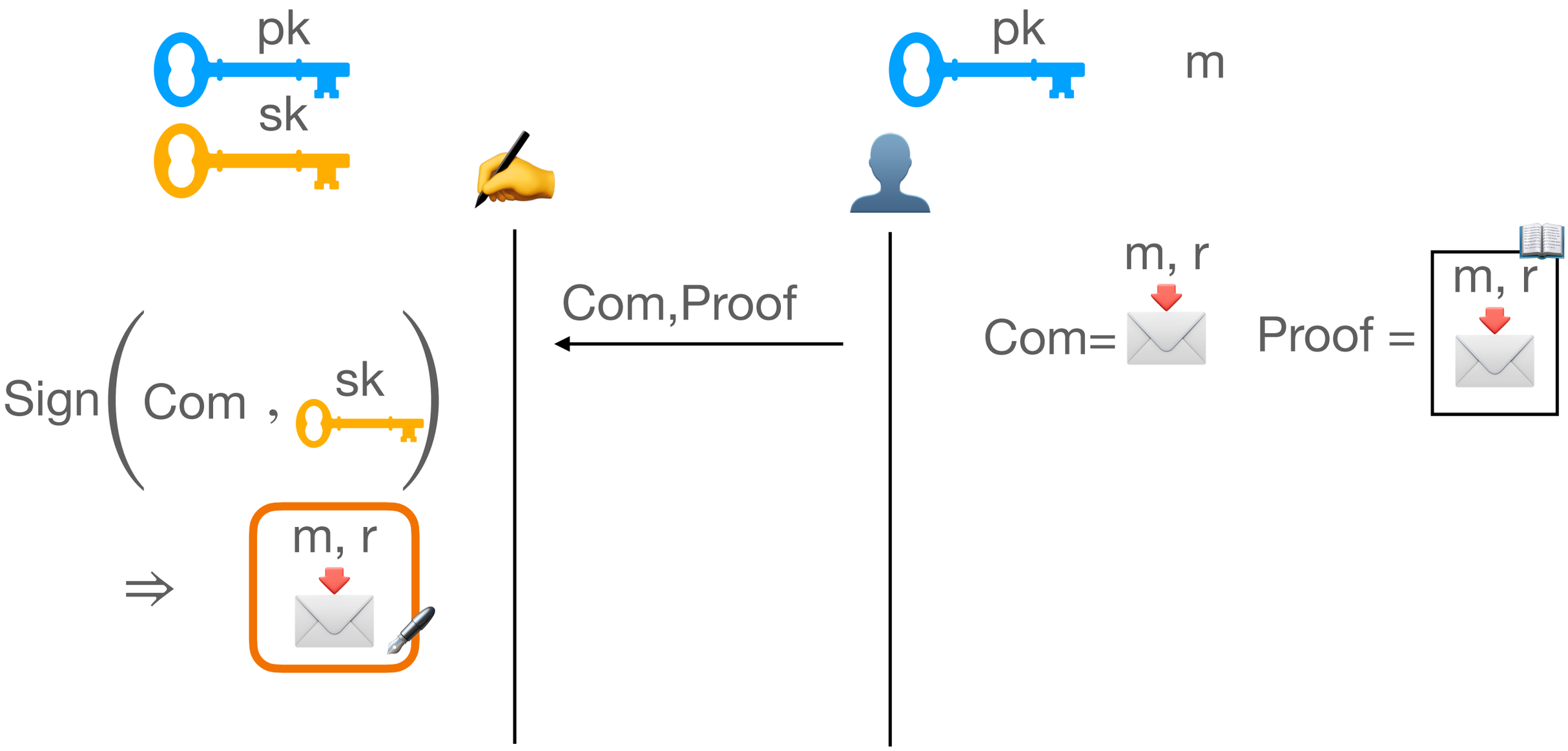

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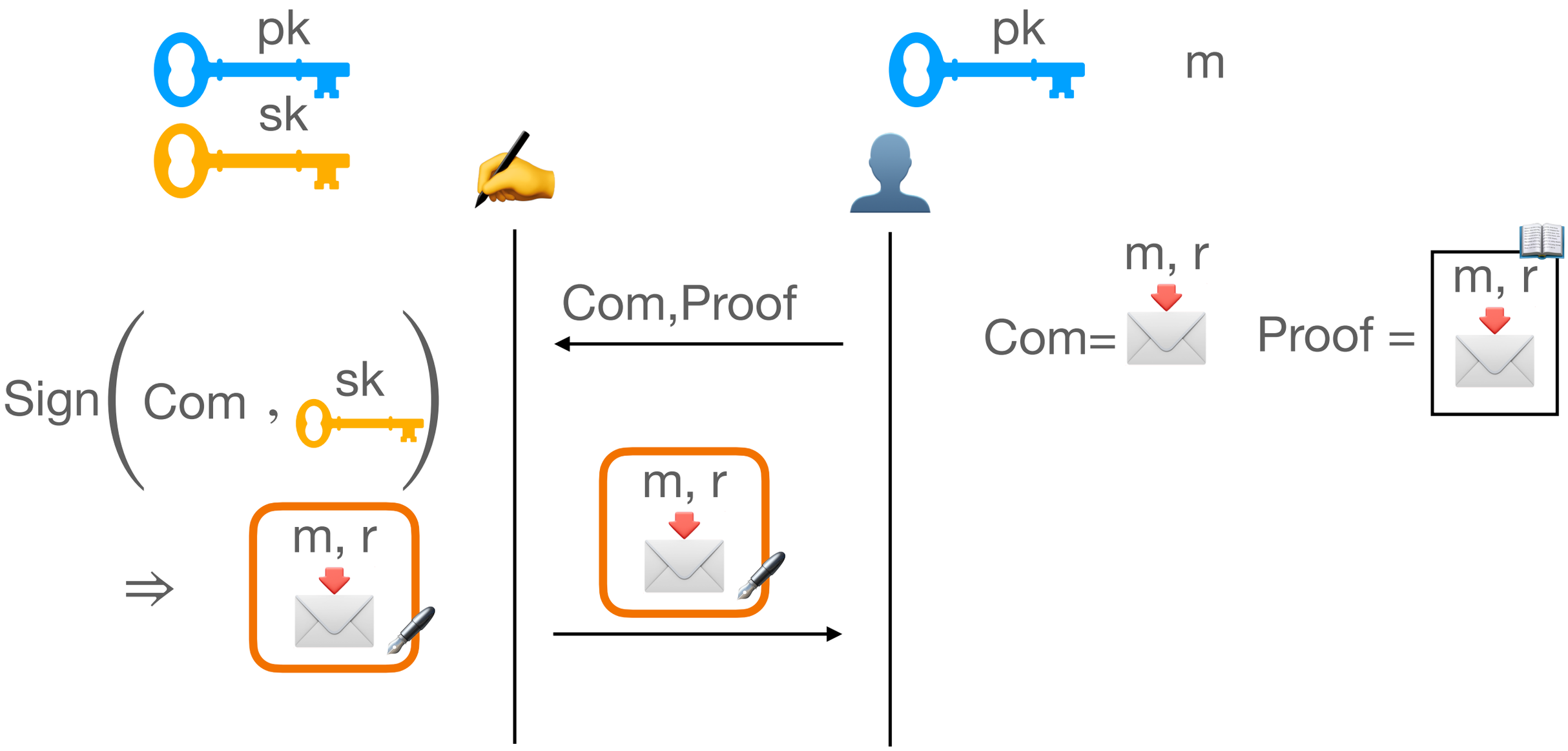

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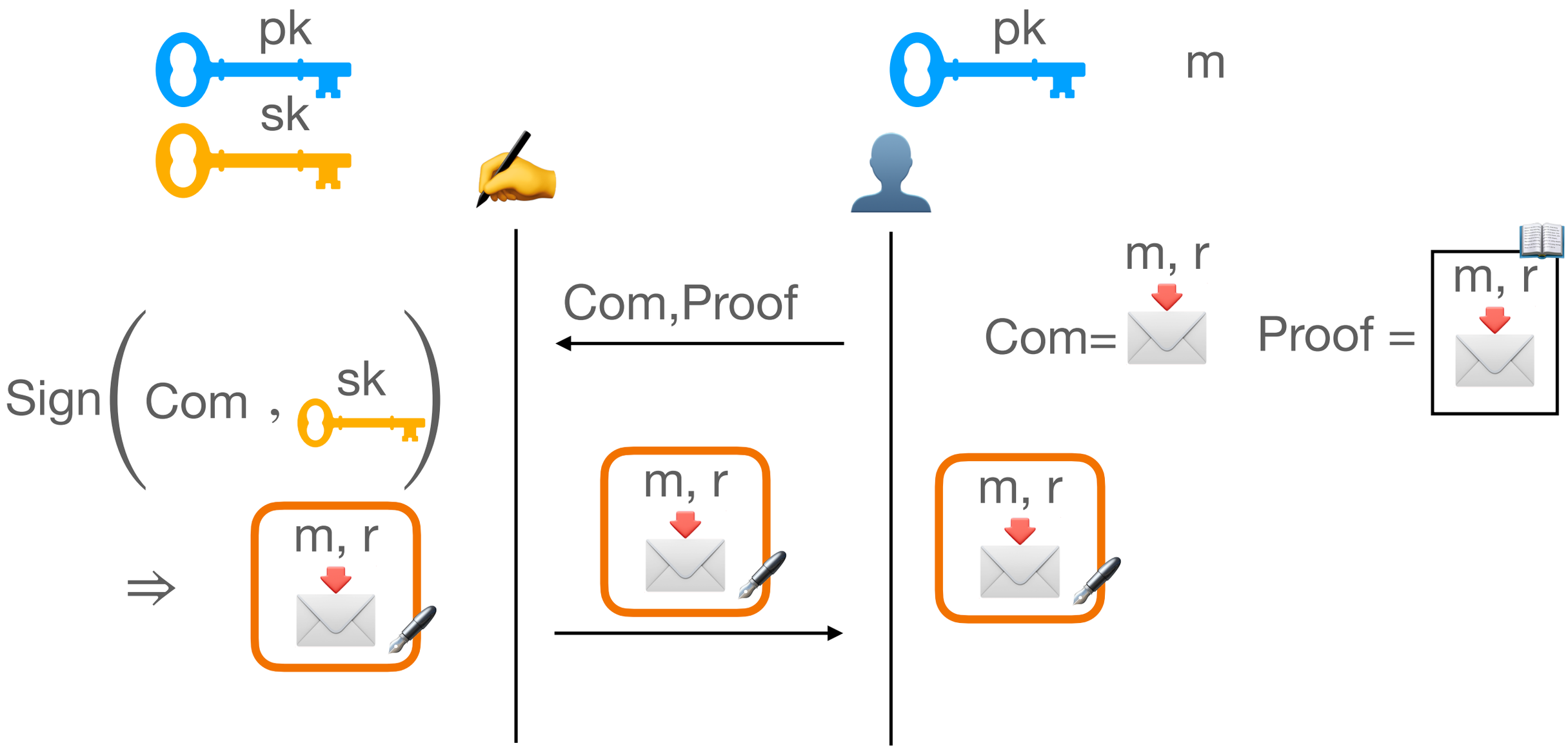

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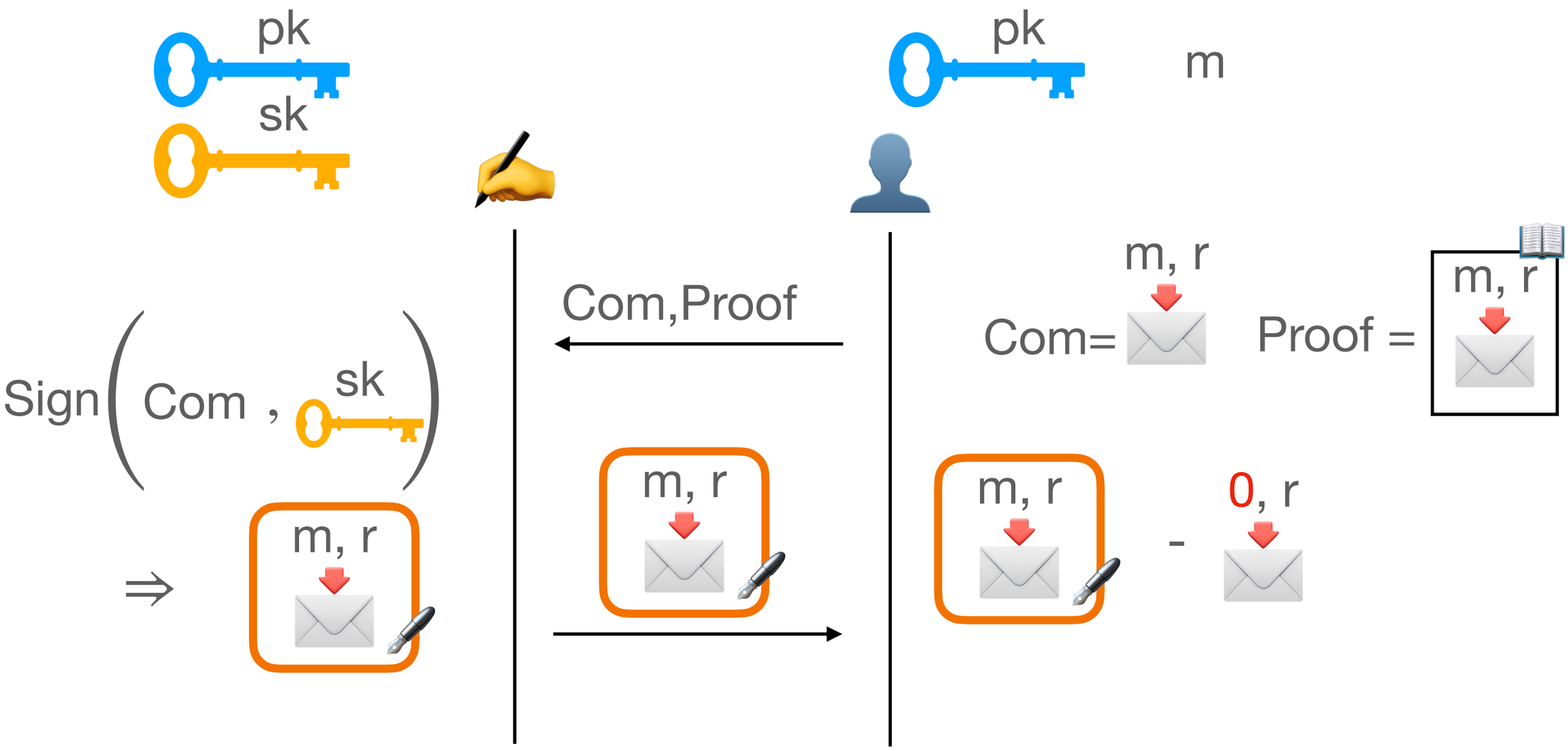

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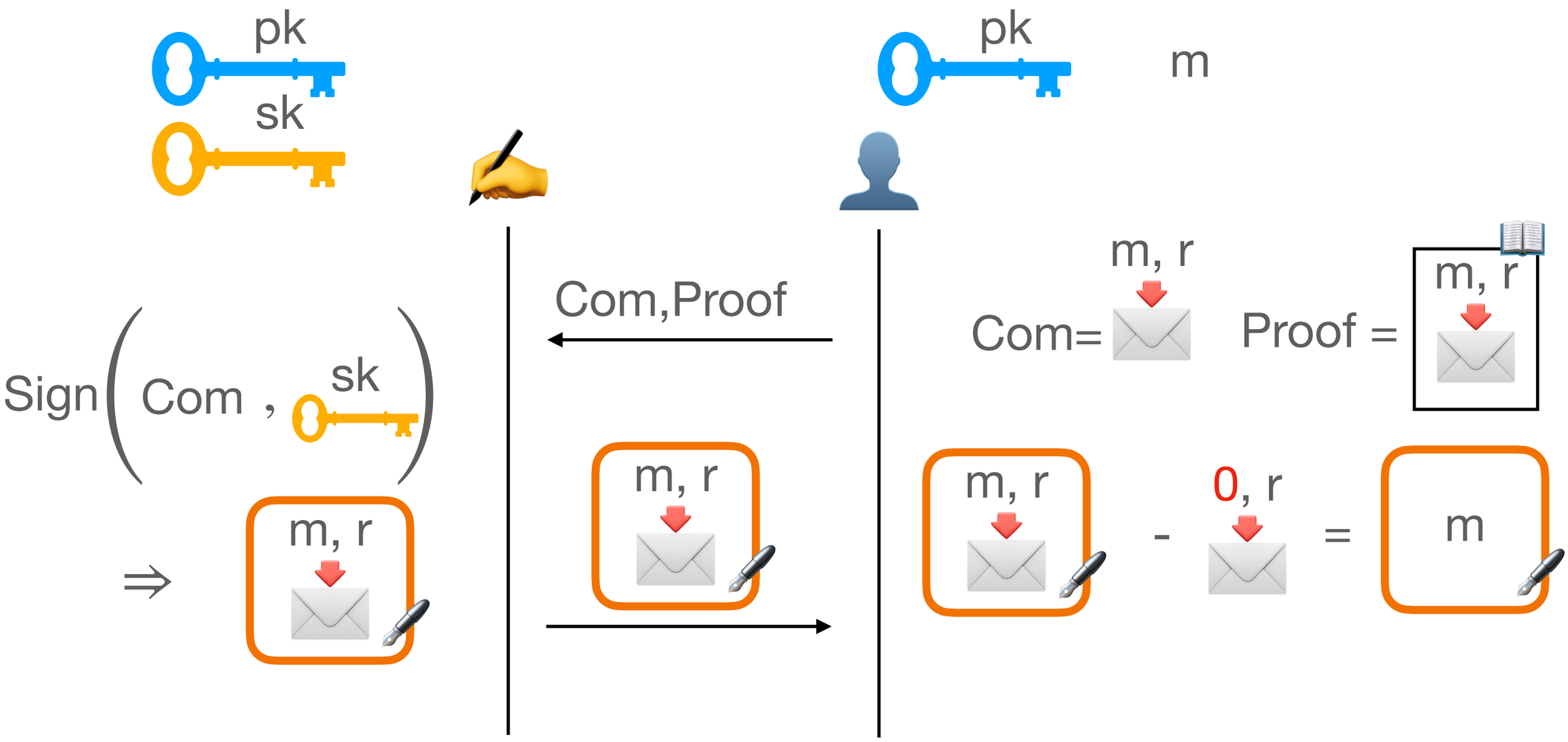

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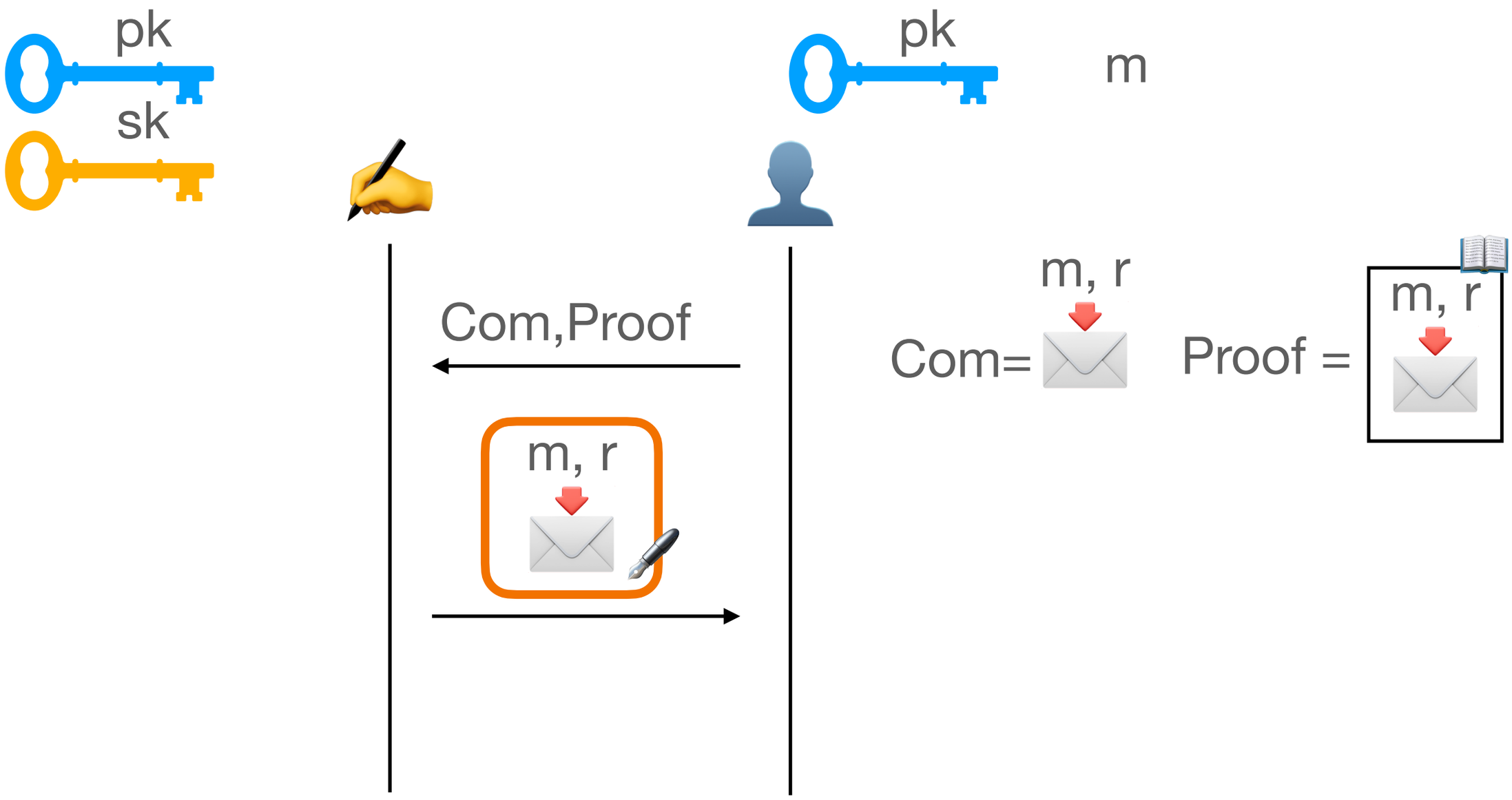

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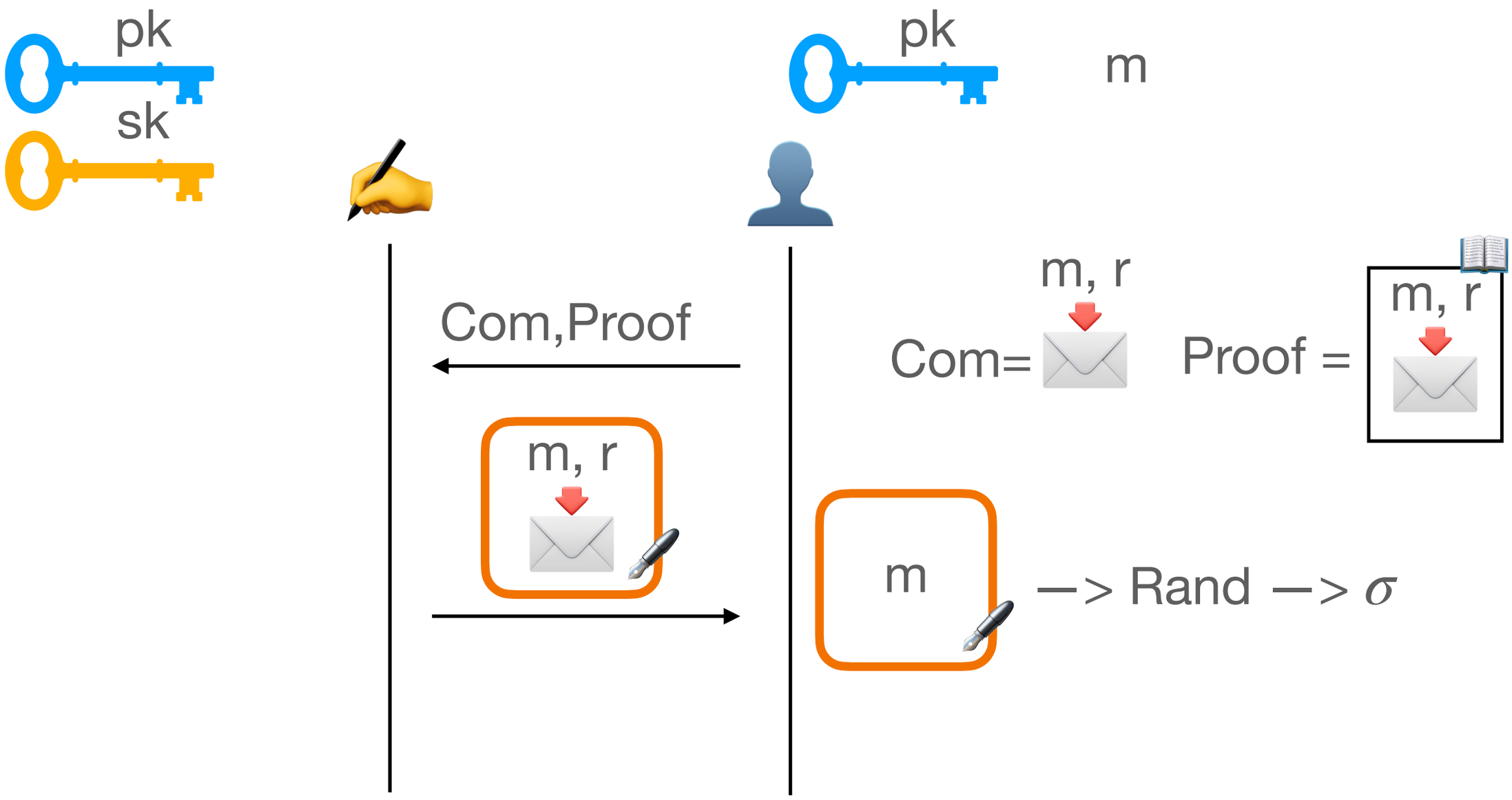

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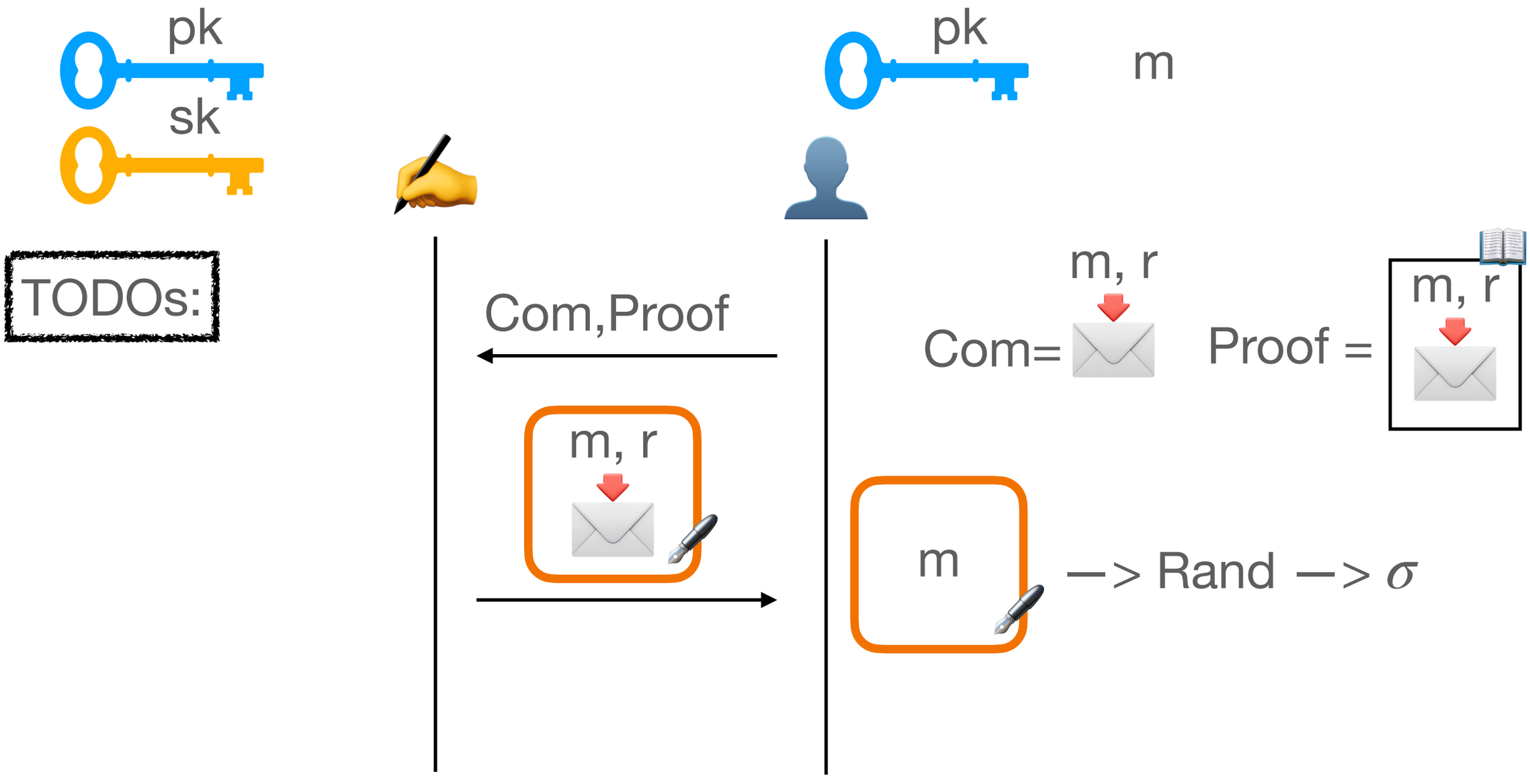

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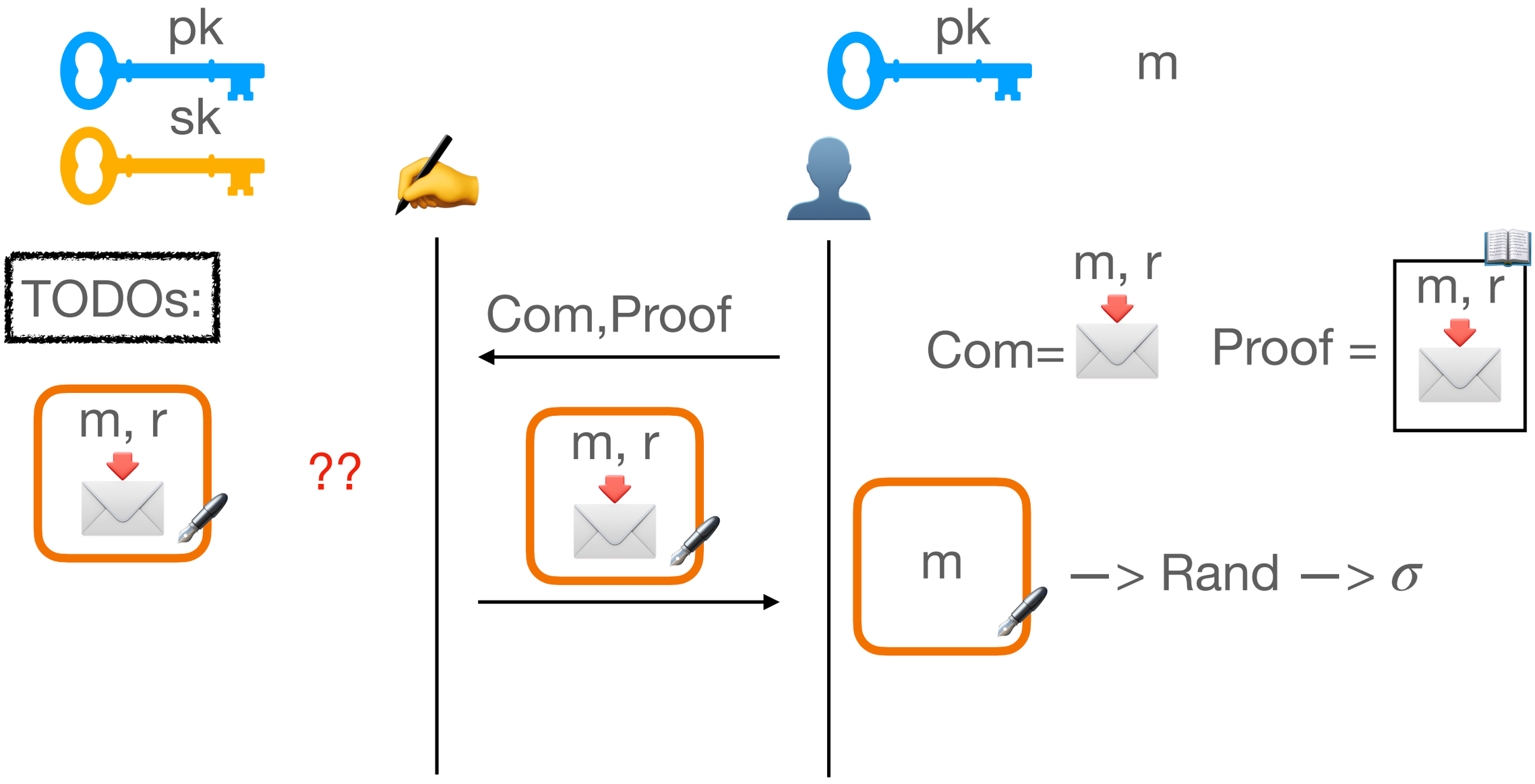

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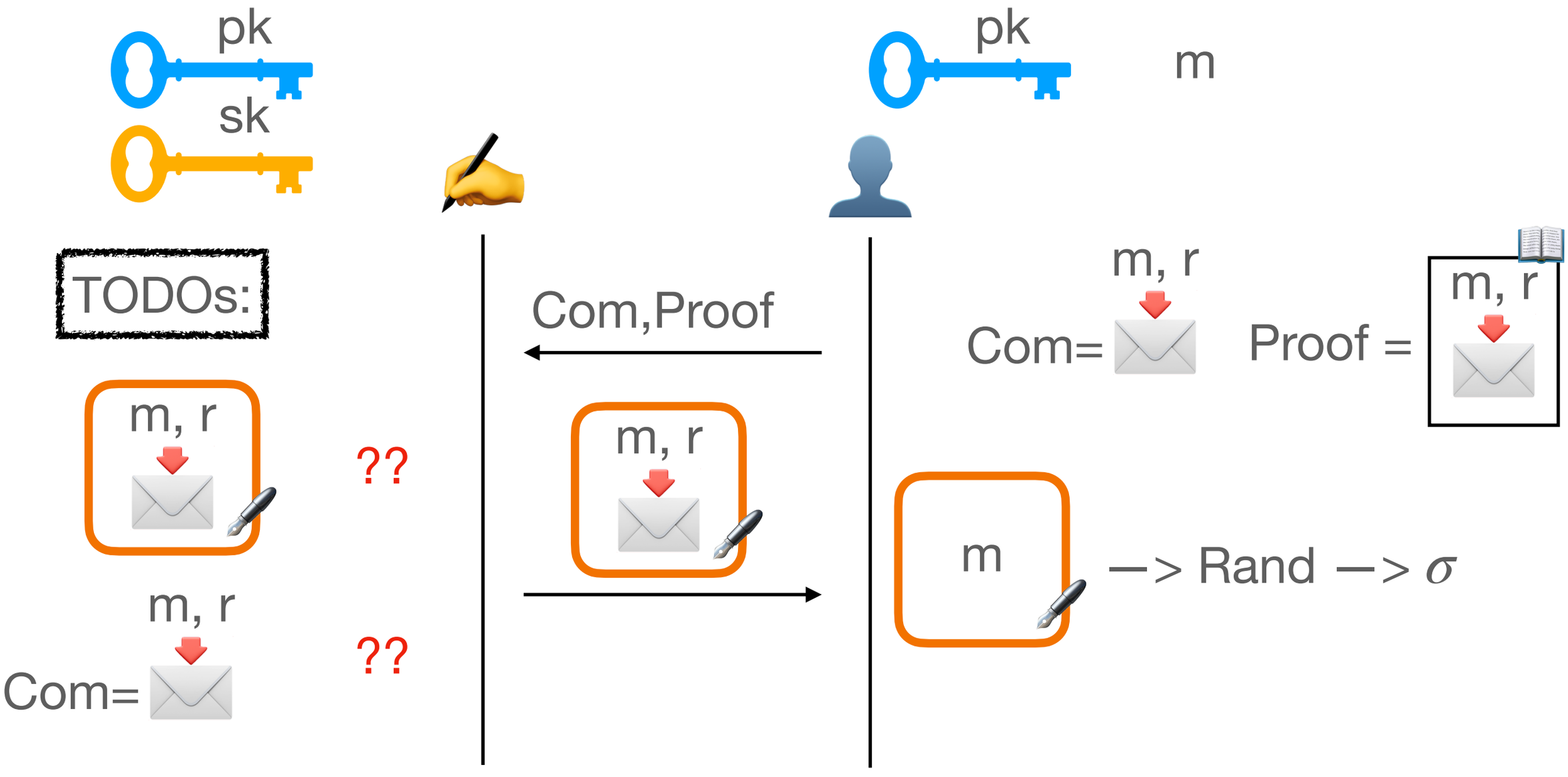

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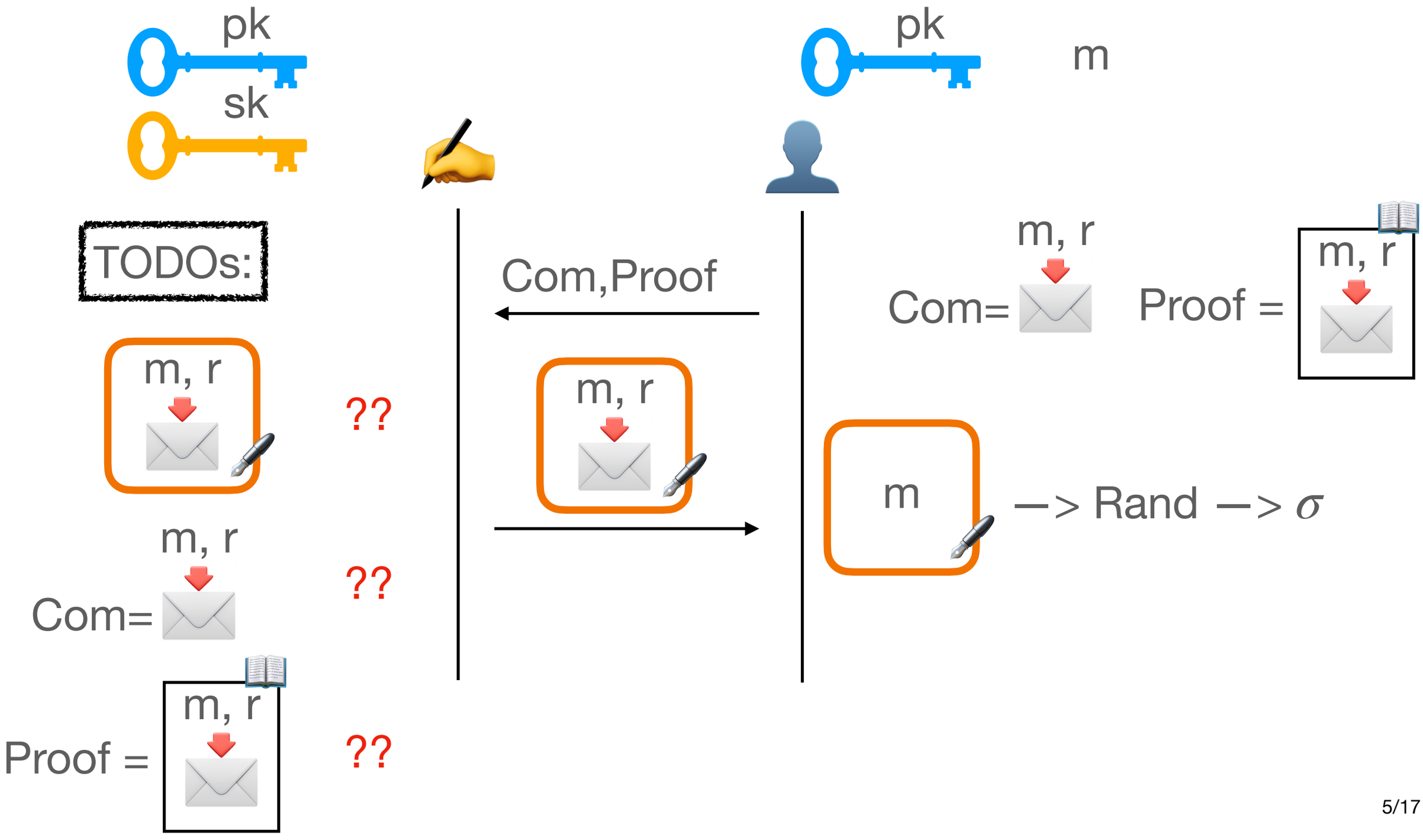

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—> Modified Fischlin-Cramer-Shoup [Fischlin03,Cramer-Shoup99]
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Properties:

(NIZK-friendly) Fixing m,
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Simulated signing
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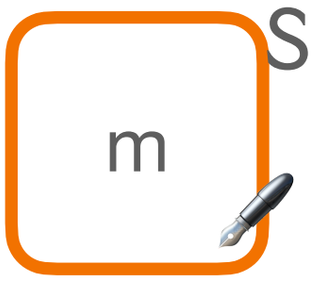
Our S_{fis} in Sect. 4

Our Commitment for Fischlin



S_{fis}

; Com= 

m, r

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Req1: S_{fis}-compatible


Req2: add. homomorphic

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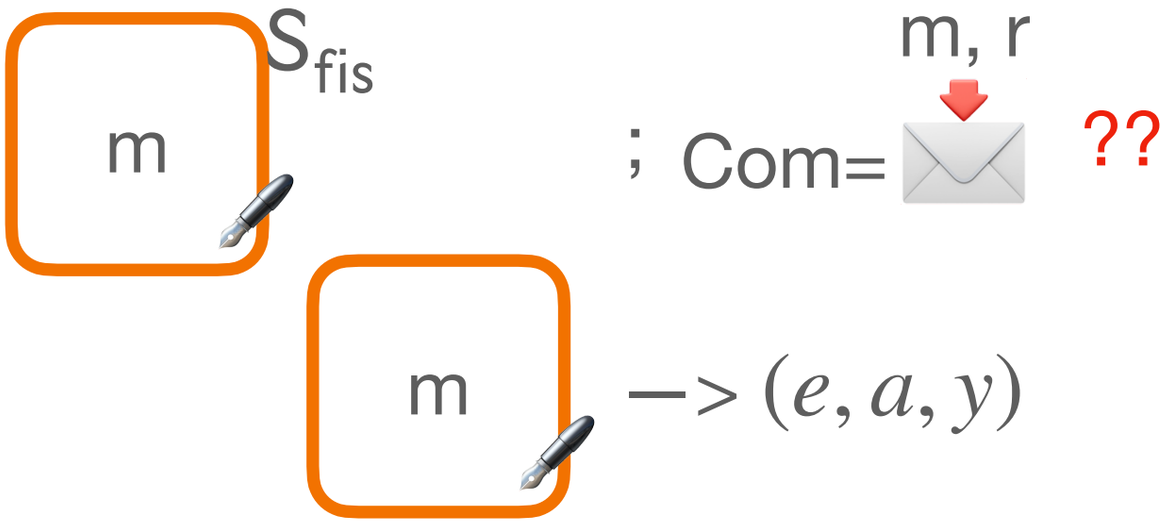

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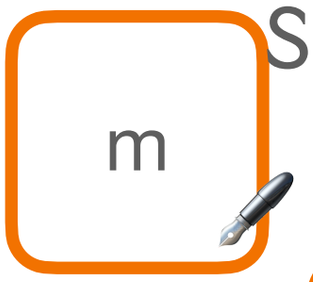

S_{fis}

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$\longrightarrow (e, a, y)$


Req1: S_{fis}-compatible


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$$y^e = h \cdot h_1^a \cdot h_2^{a+m} \mod N$$

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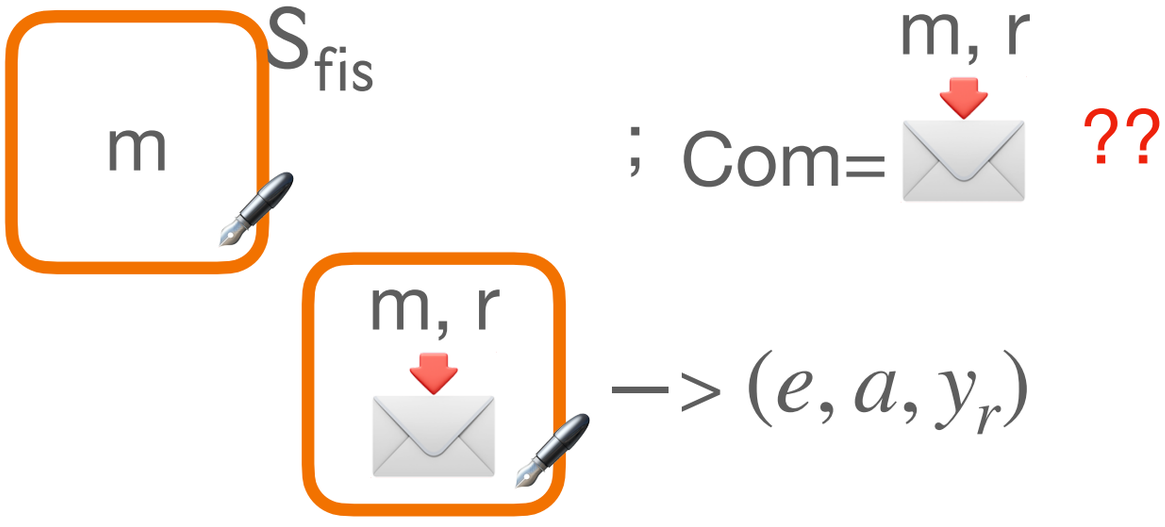

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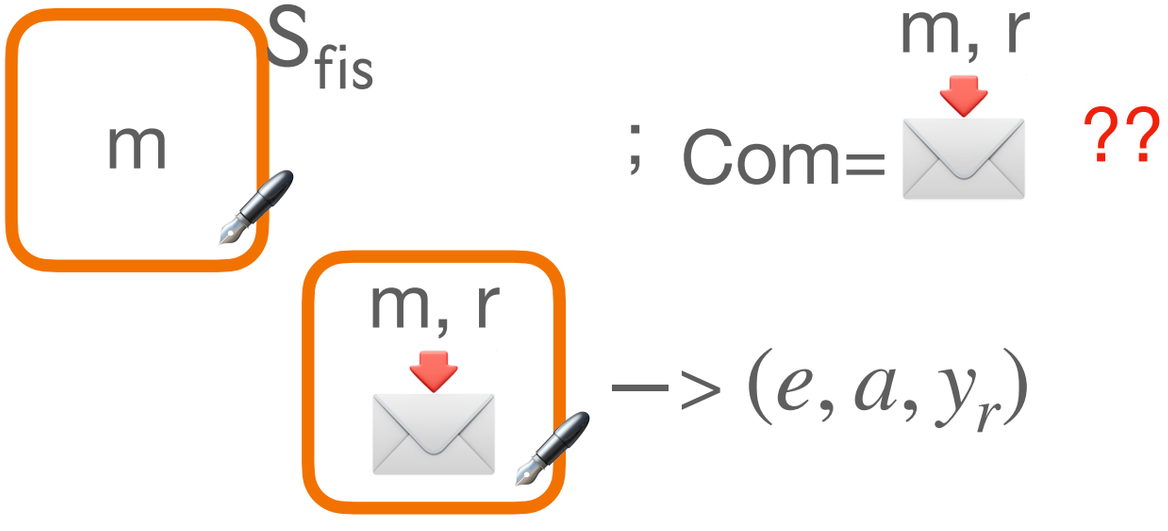

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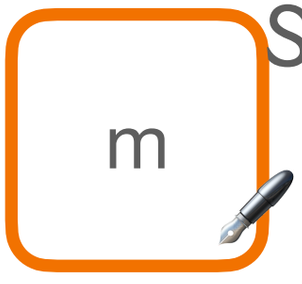

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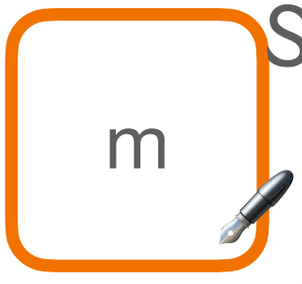

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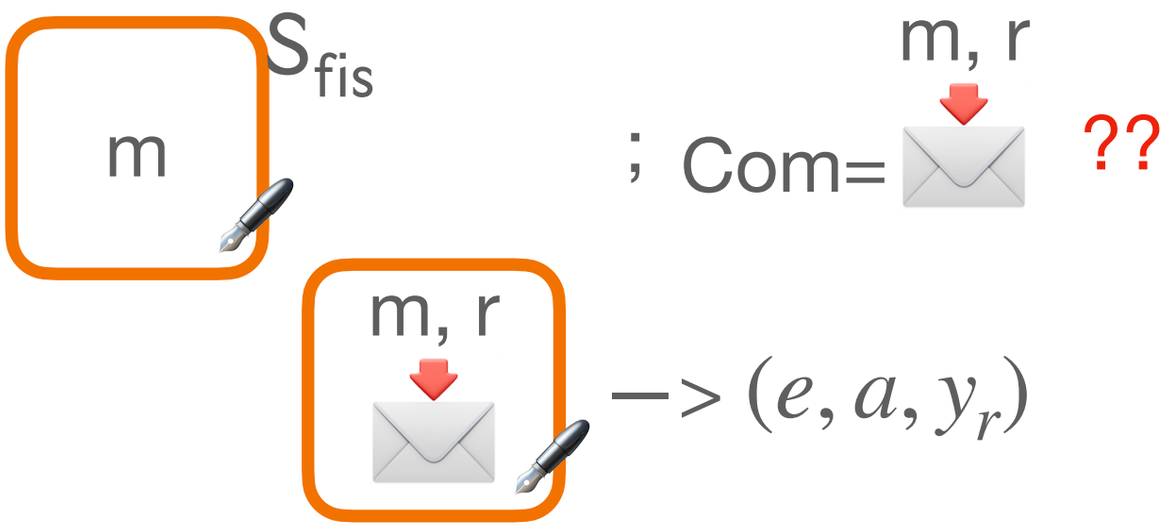

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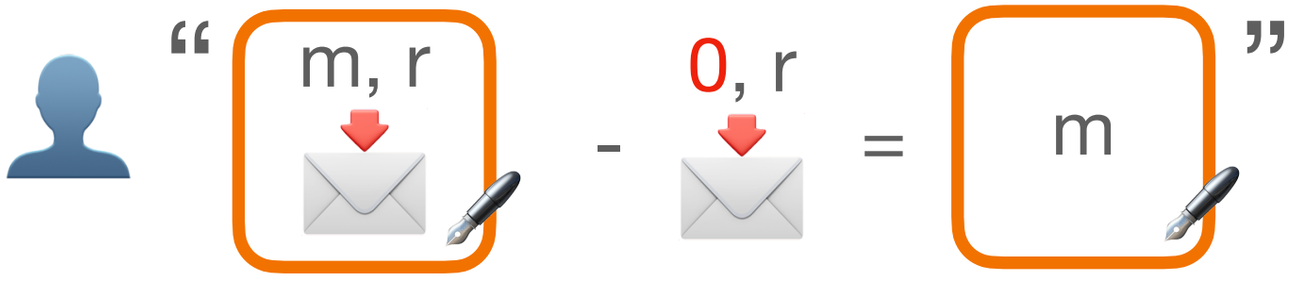

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m S_{fis} ; Com= m, r ??

- Req1: S_{fis}-compatible
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m, r $\rightarrow (e, a, y_r)$

$$y_r = \boxed{\text{m}} \cdot g^{\frac{r}{e}} \mod N$$

1st try: m, r $= h_2^m \cdot g^r \mod N$

“ m, r - 0, r = m ”

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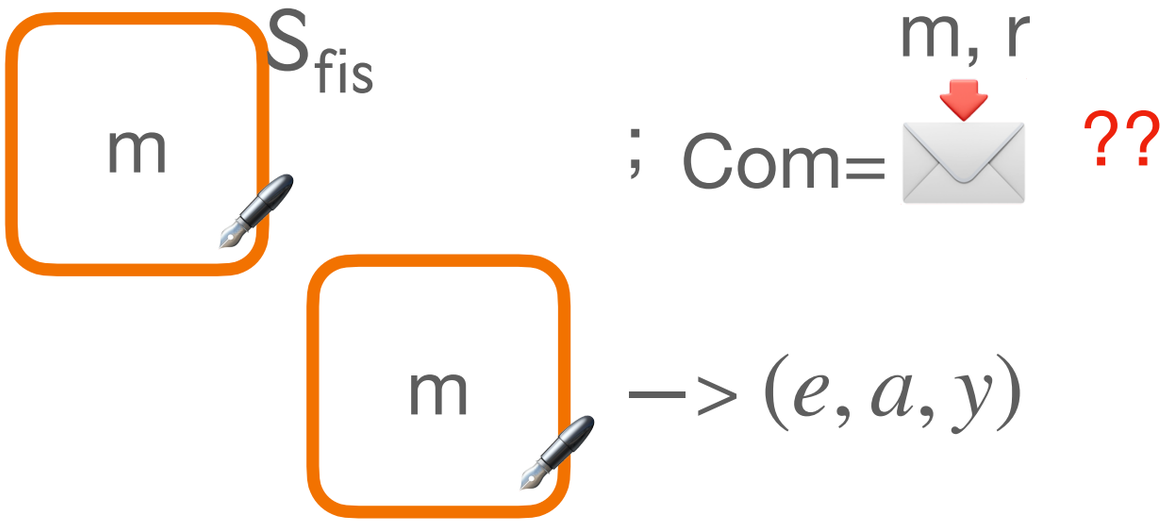

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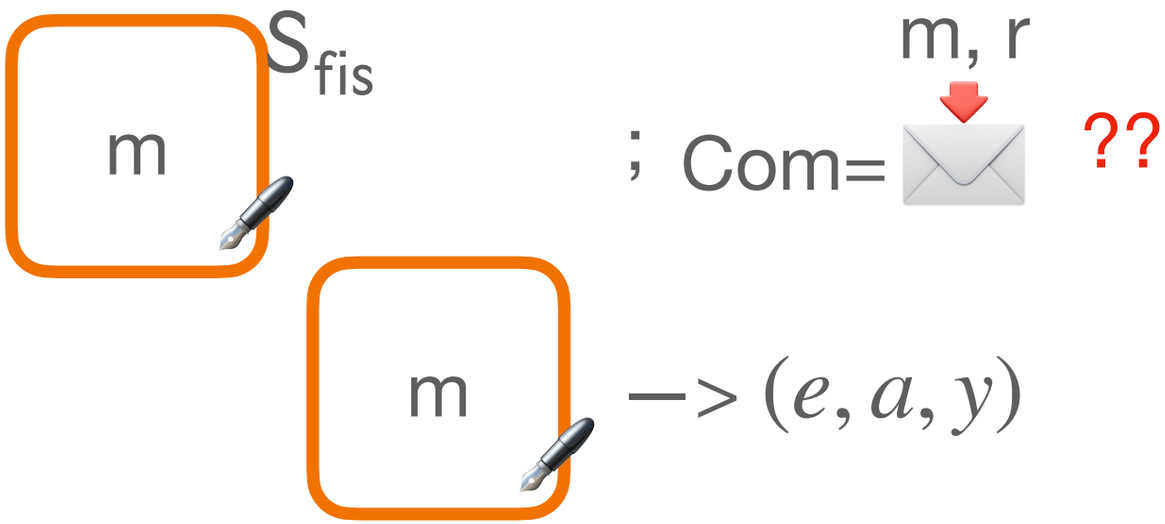

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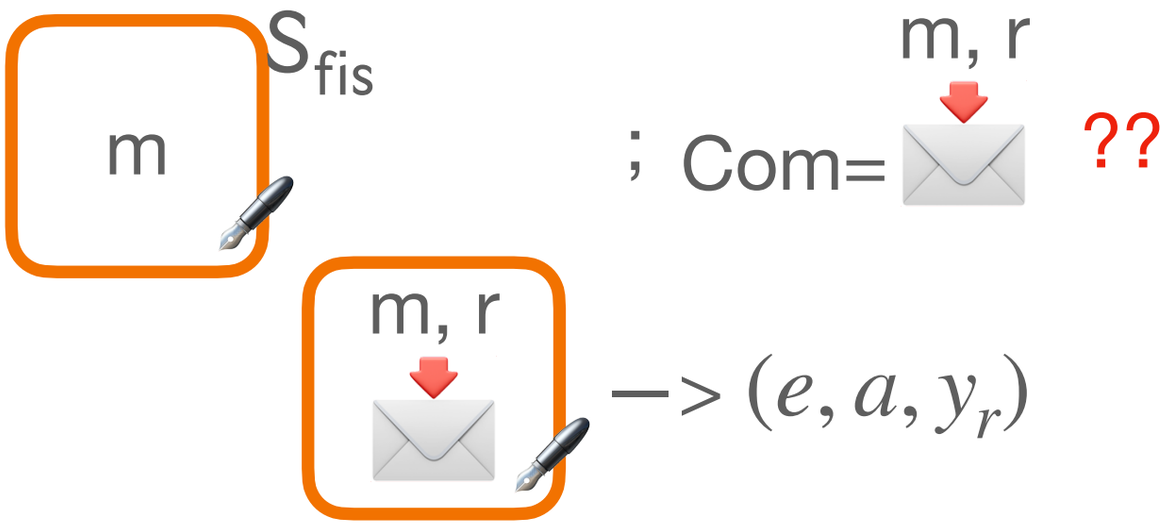

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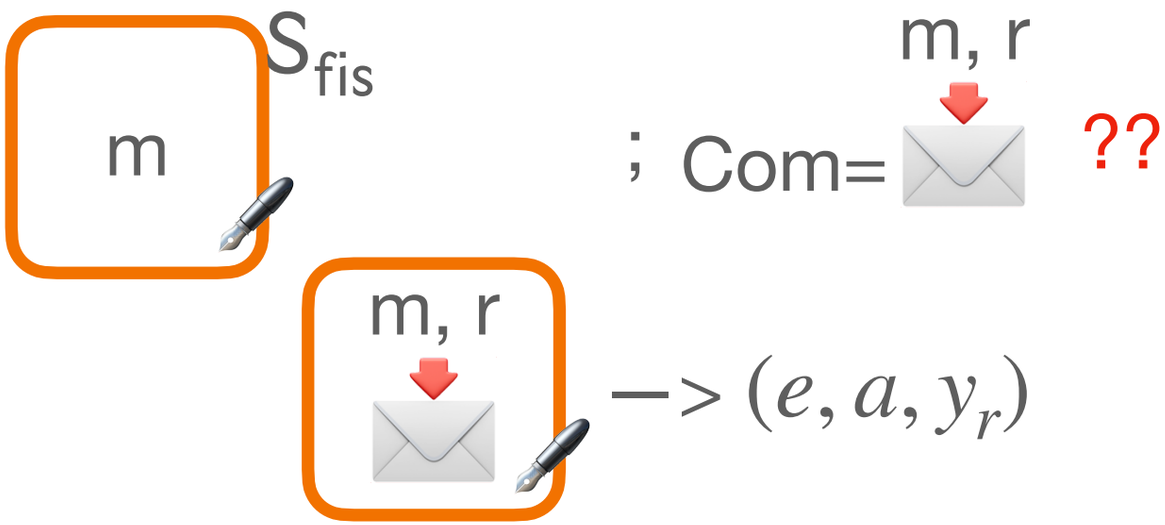

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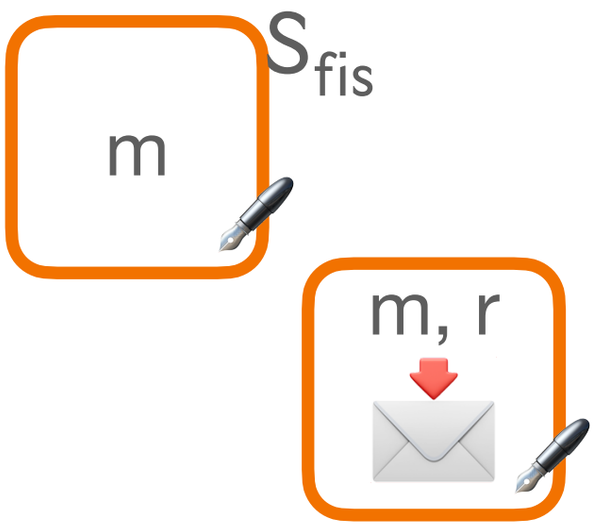

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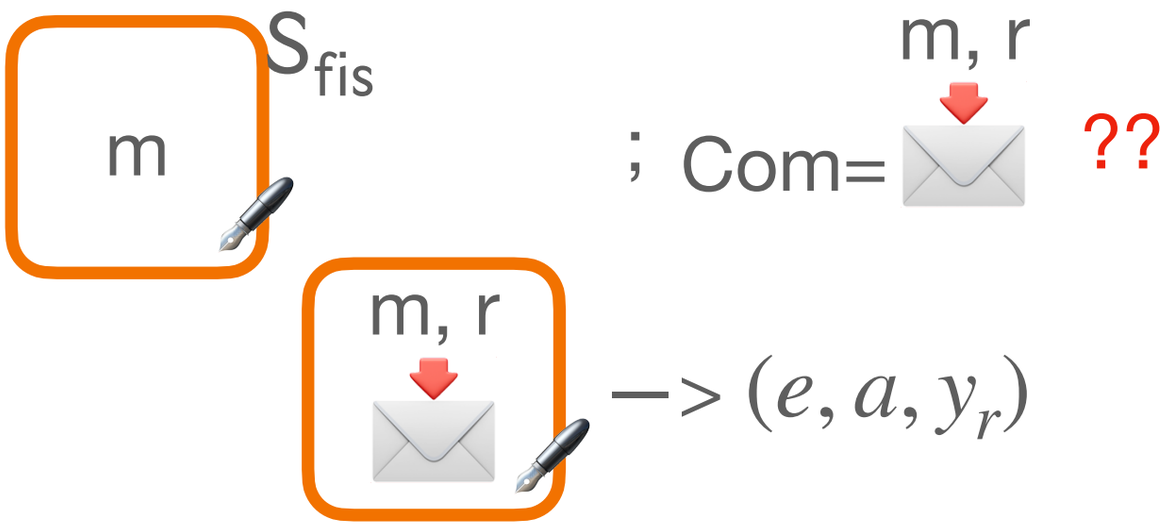

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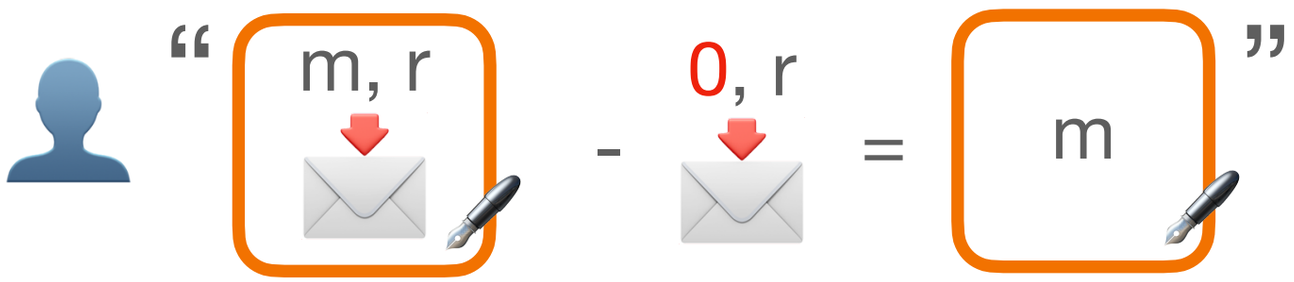

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$\rightarrow (e, a, y_r)$

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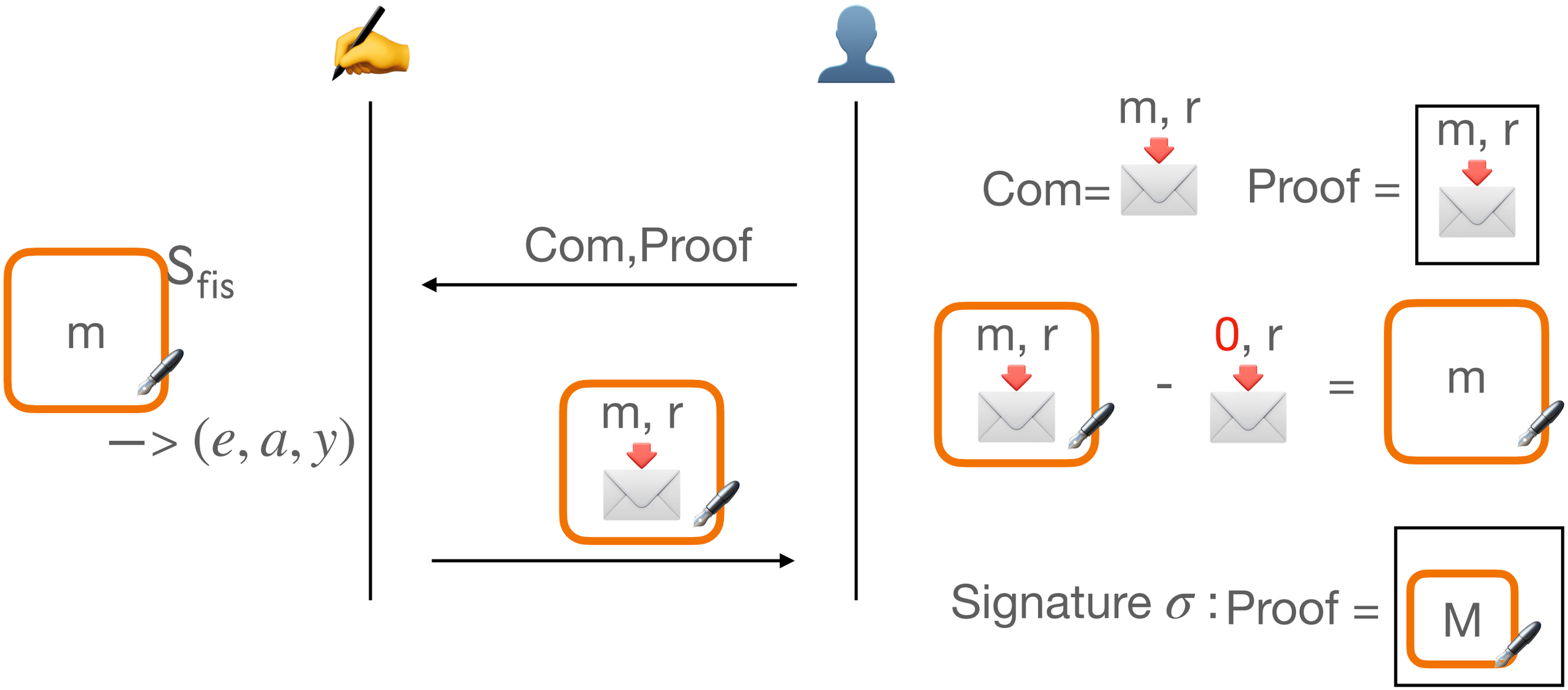
Dealing with e from S_{fis}



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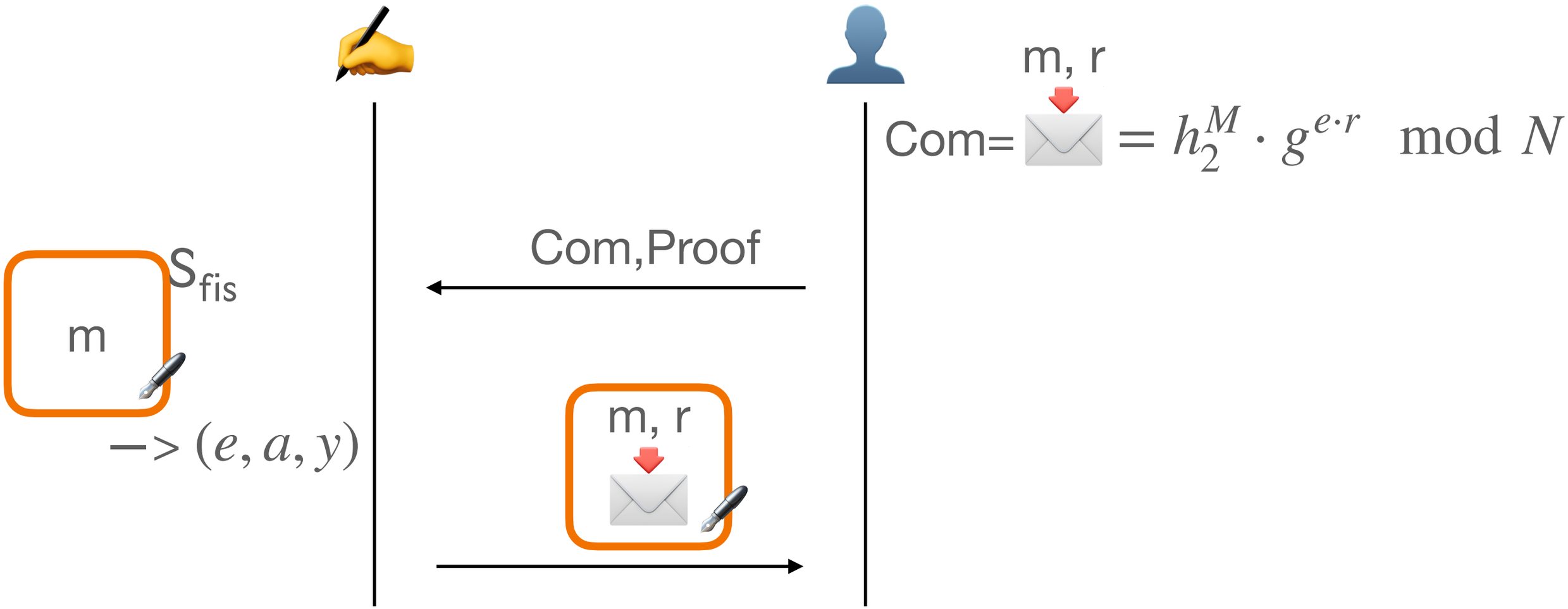

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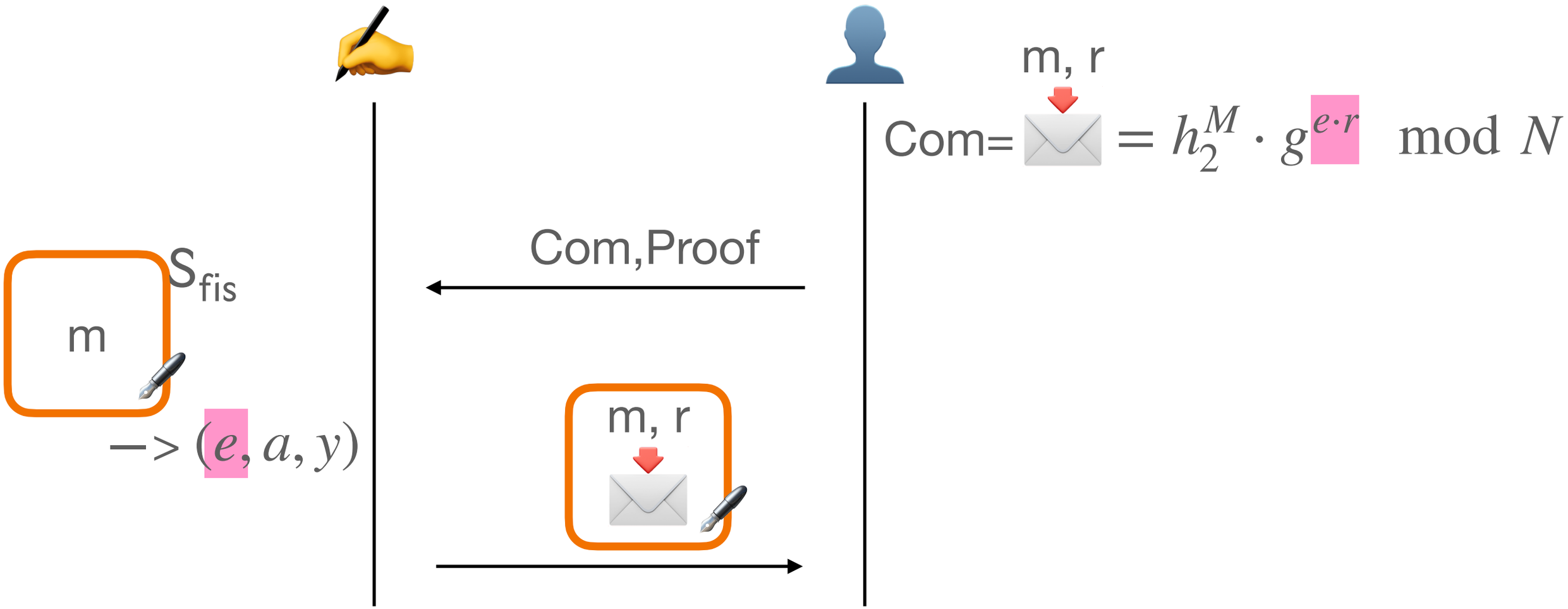

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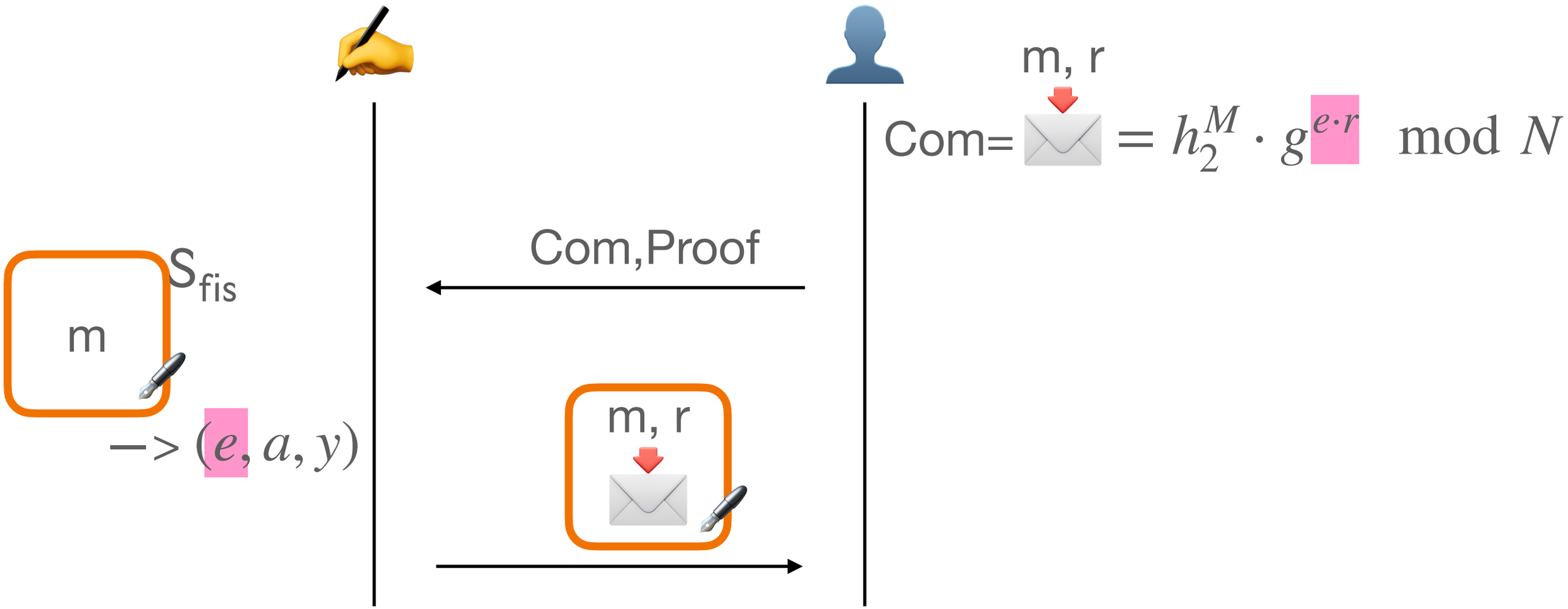

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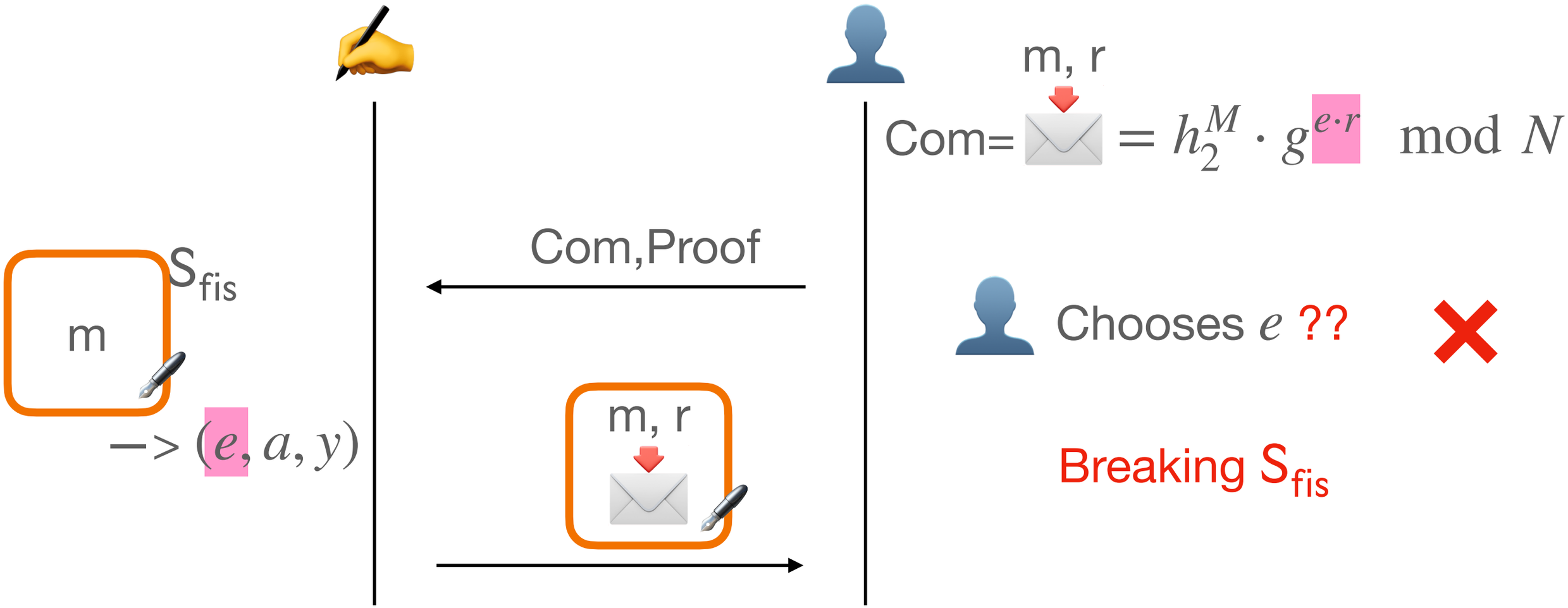

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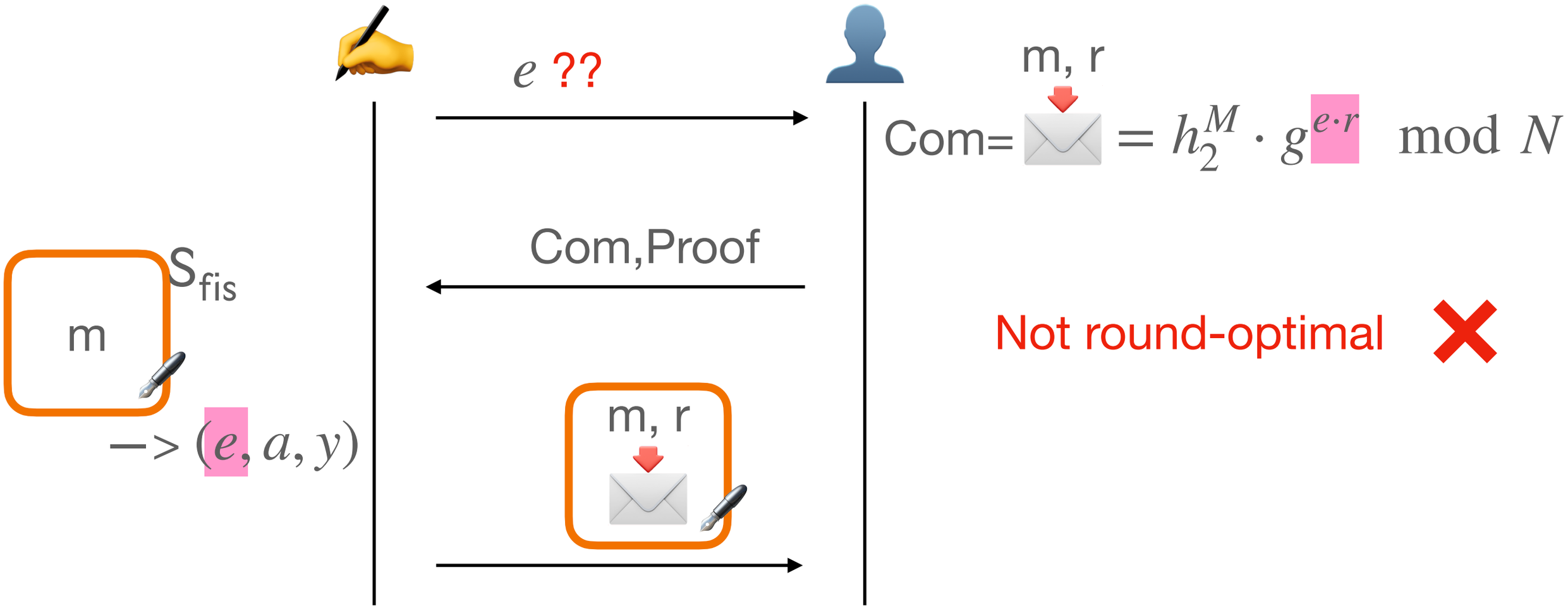

Not round-optimal ❌

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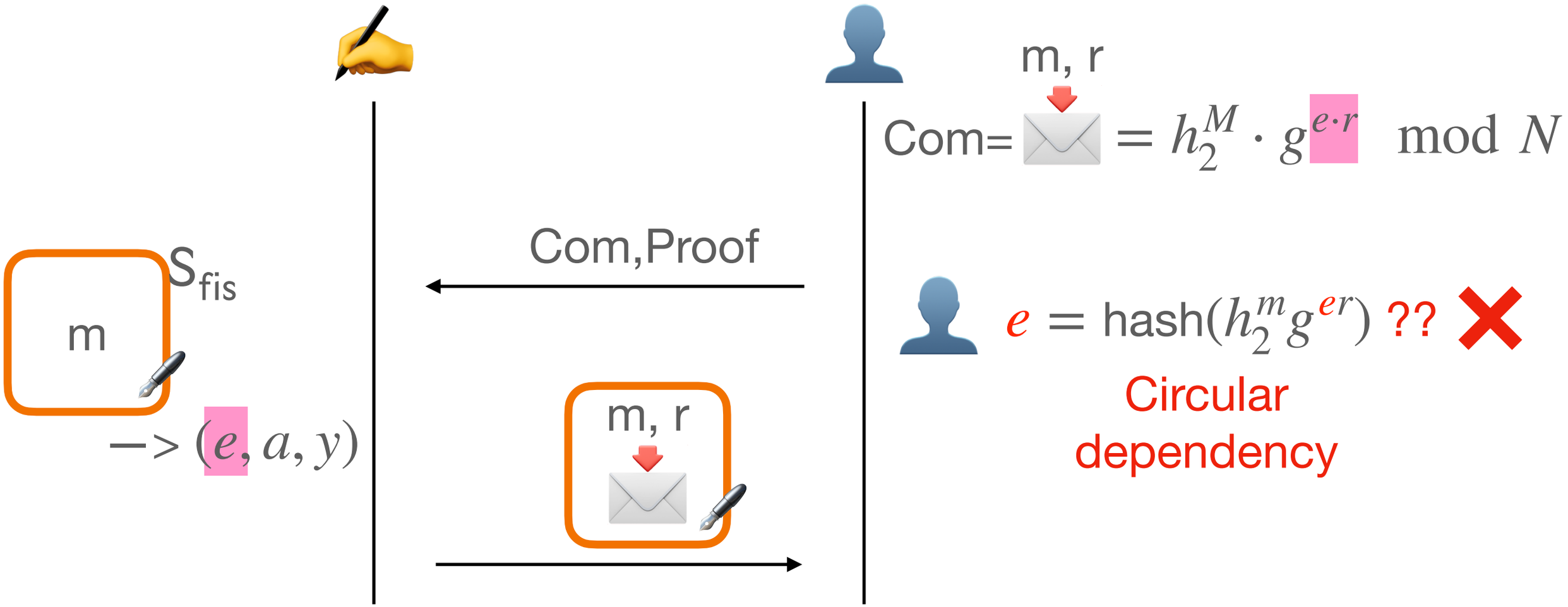

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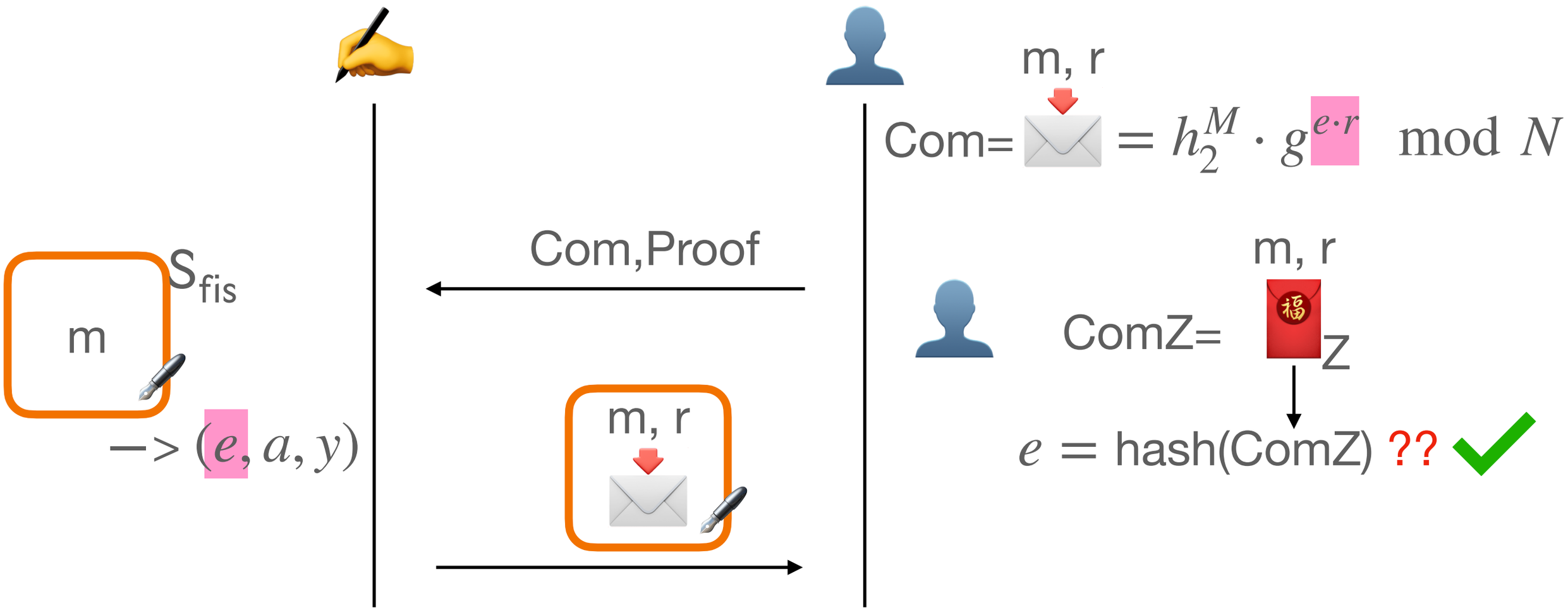

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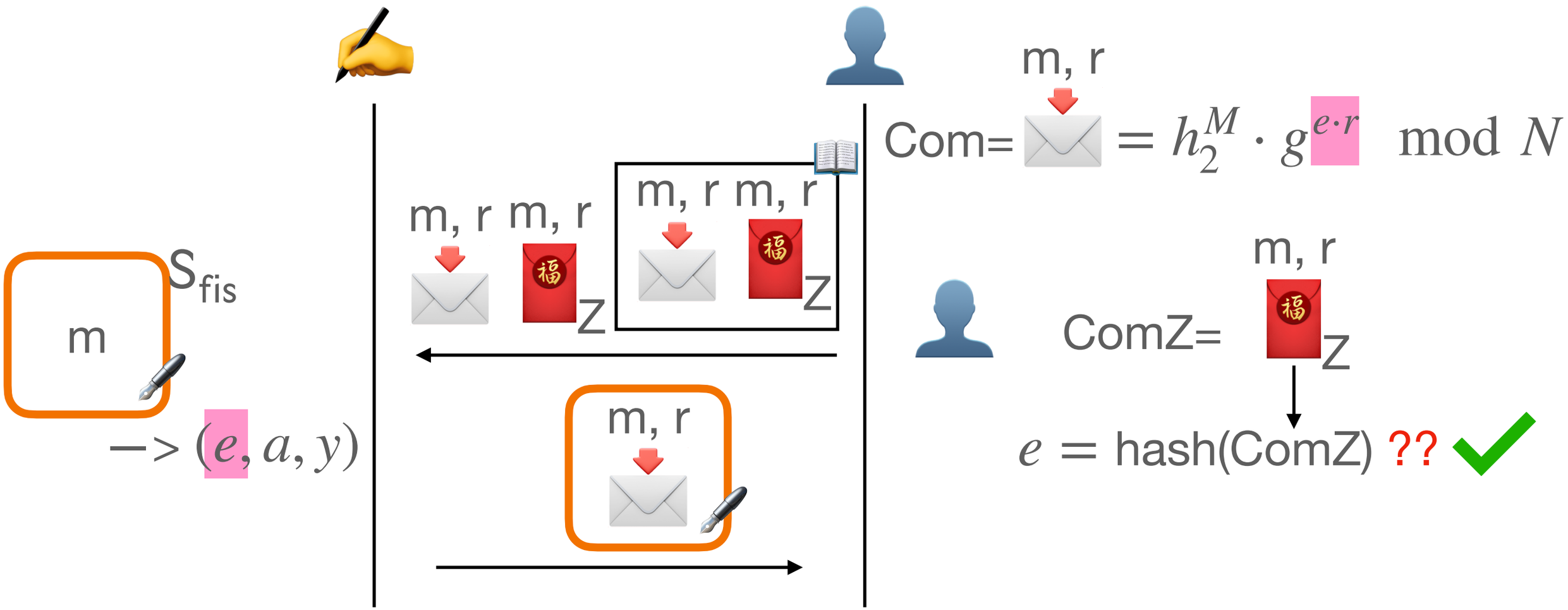
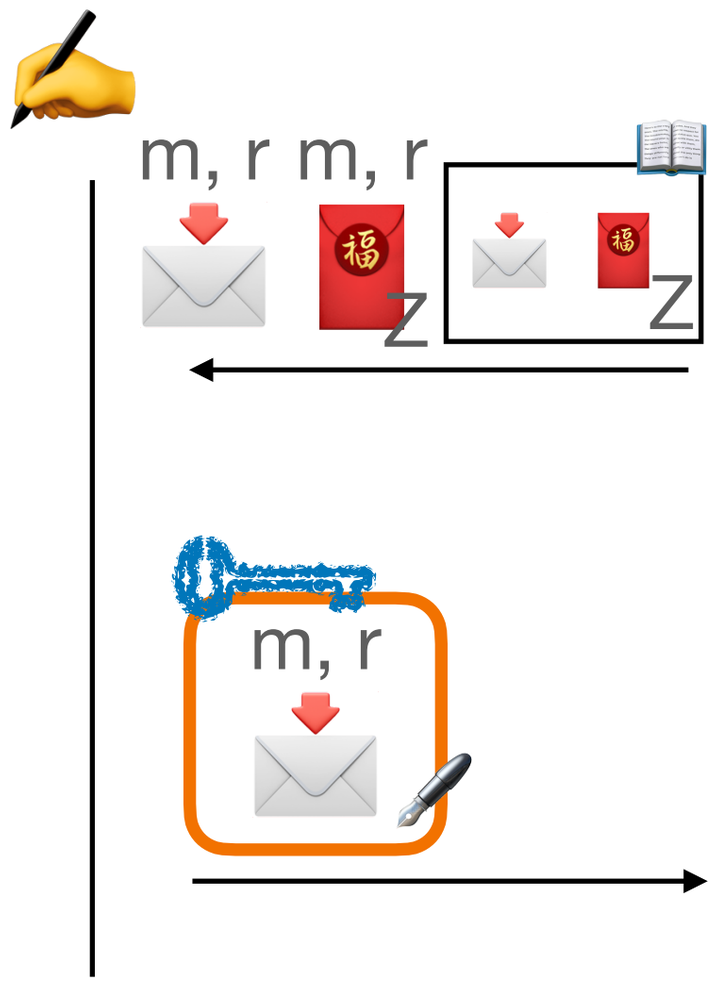


One-More Unforgeability (1)

Simulating signing queries

(Setup w/ trapdoors)

Simulated signing by trapdoors in

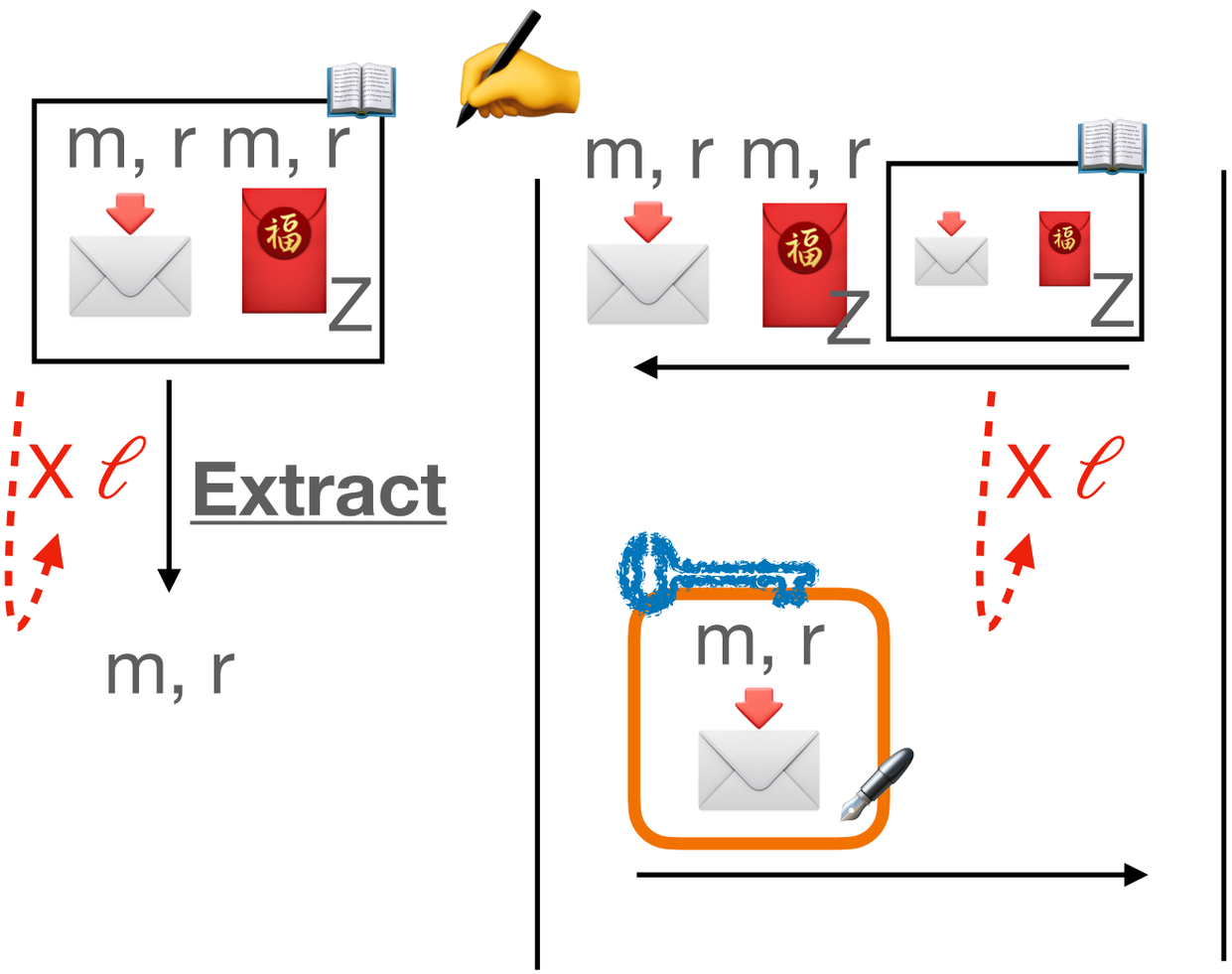


One-More Unforgeability (1)

Simulating signing queries

(Setup w/ trapdoors)
Simulated signing by trapdoors in sim-pk

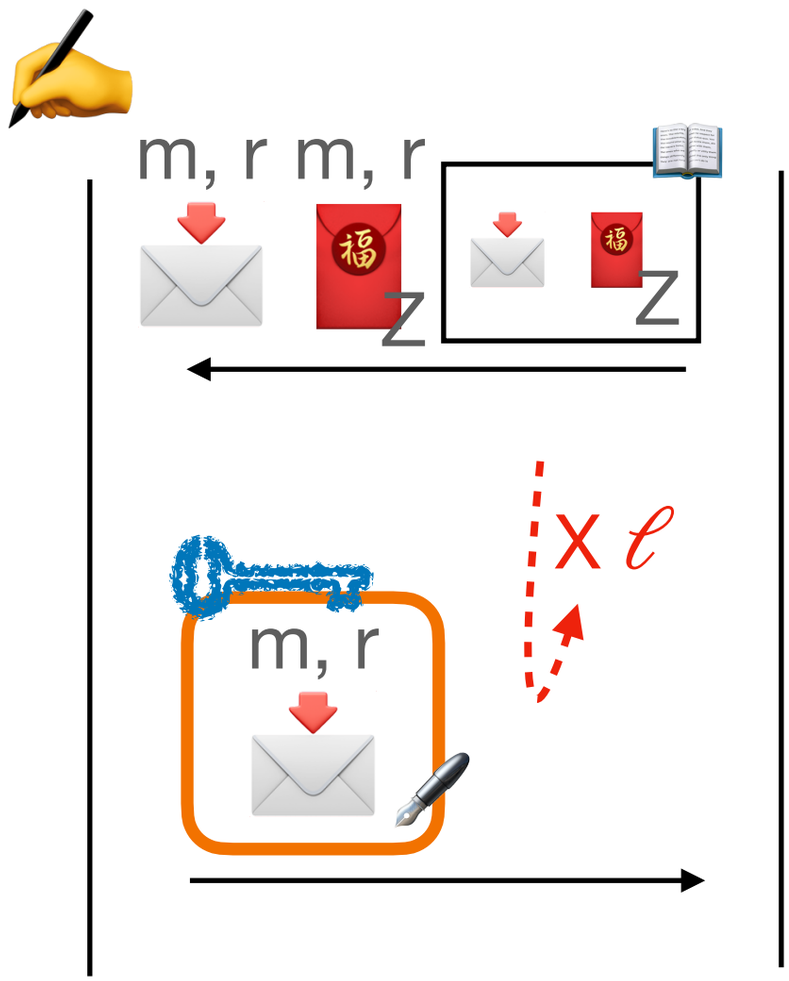
(Online-extractable)



One-More Unforgeability (2)

Exploit the forgery

(NIZK-friendly)
Fixing m,
have NIZKPoK



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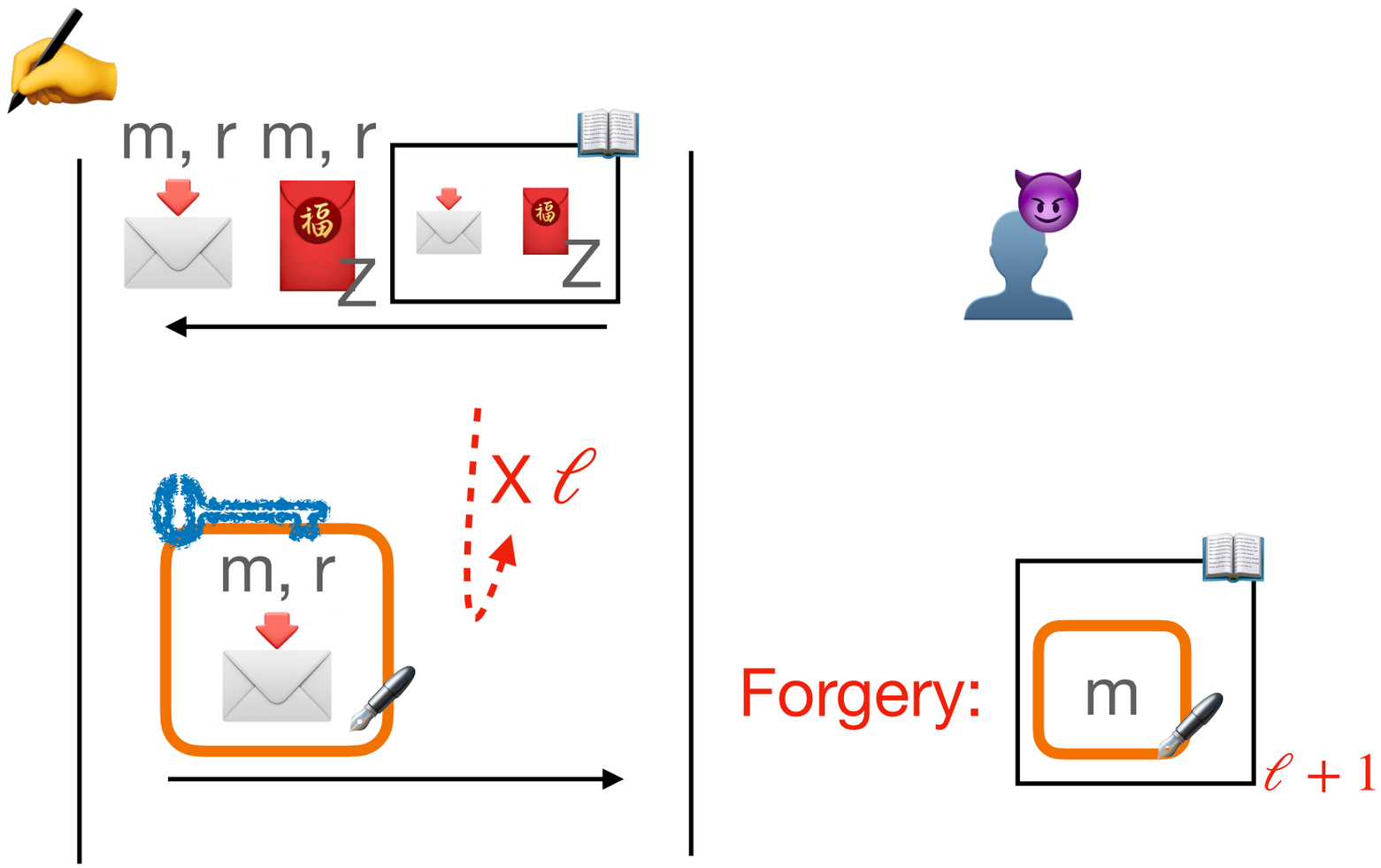


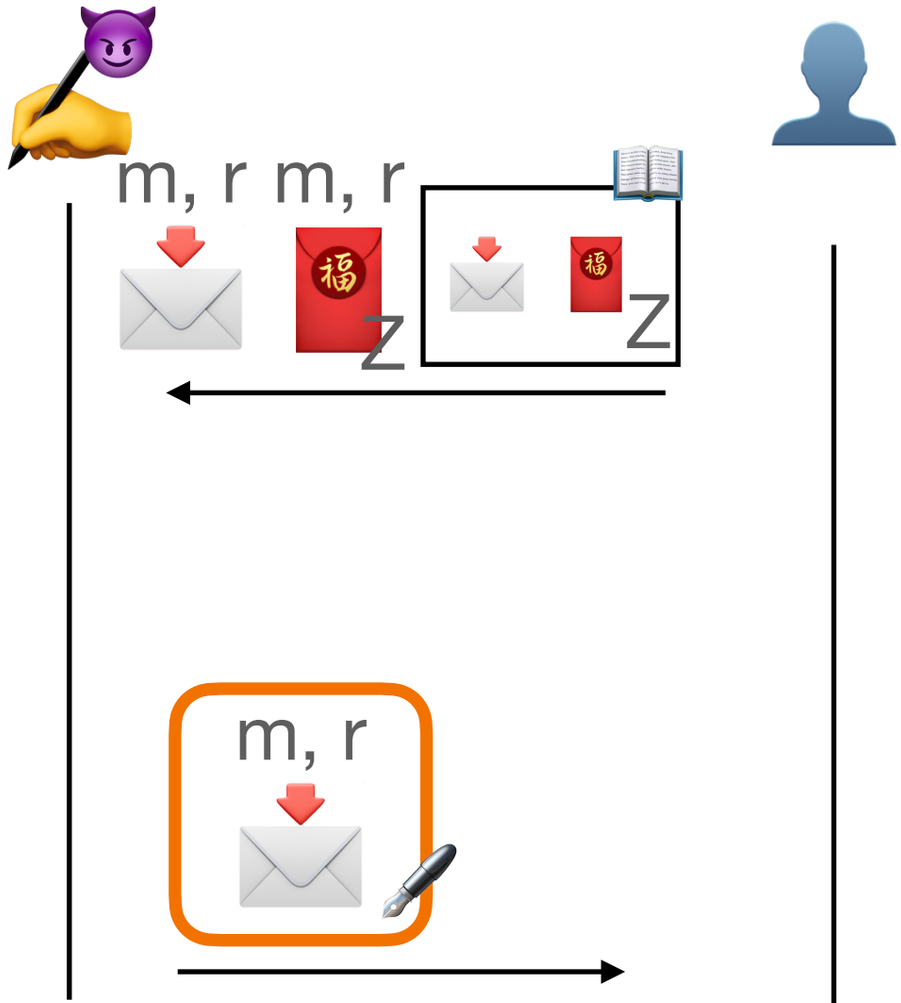
(Rewinding) **ExtractFis**

(e, a, y)

Malicious Blindness (1)

Problems from Malicious Signer - Commitments Not Hiding

pk $= (N, h, h_1, h_2)$; crs



Malicious Blindness (1)

Problems from Malicious Signer - Commitments Not Hiding

pk $= (N, h, h_1, h_2)$; crs

m, r

$= h_2^m \cdot g^{e \cdot r} \mod N$

m, r m, r

Z Z

m, r

m, r

N

m, r

Z

NOT HIDING !!

m, r

Malicious Blindness (2)

Commitments Not Hiding - Our Solution

m, r

$$= h_2^m \cdot g^{e \cdot r} \mod N$$

😈

Malicious Blindness (2)

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$\langle h_2 \rangle = \langle g \rangle$

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$$\Rightarrow$$

Large enough r gives hiding

Malicious Blindness (2)

Commitments Not Hiding - Our Solution

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$= h_2^m \cdot g^{e \cdot r} \mod N$

Compact Commitments In Arbitrary Groups

proves subversion-SND

$\langle h_2 \rangle = \langle g \rangle$

$\Rightarrow$

$\langle h_2 \rangle = \langle g^e \rangle \mod N$

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Problems from Malicious Signer - NIZKs Not ZK

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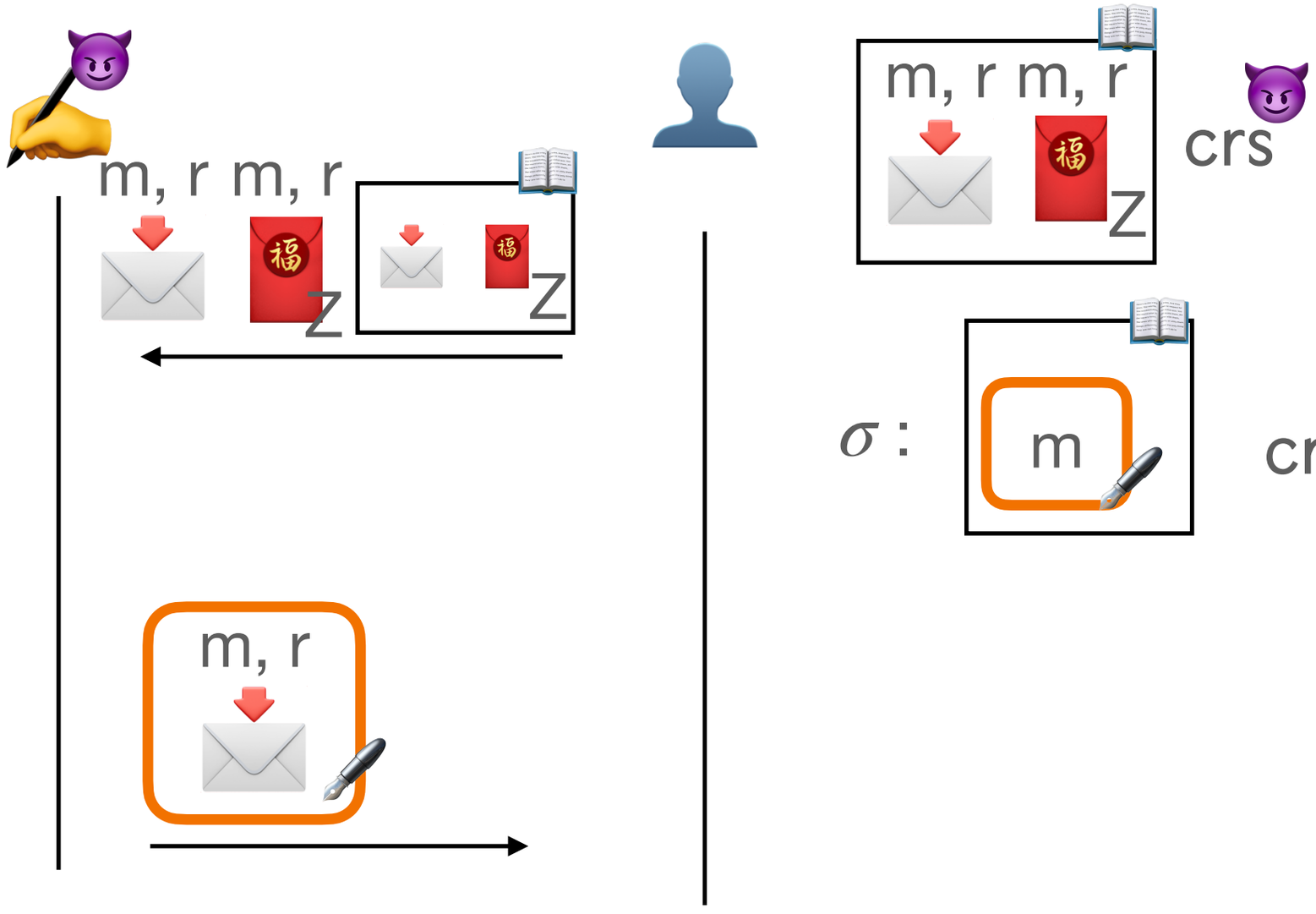

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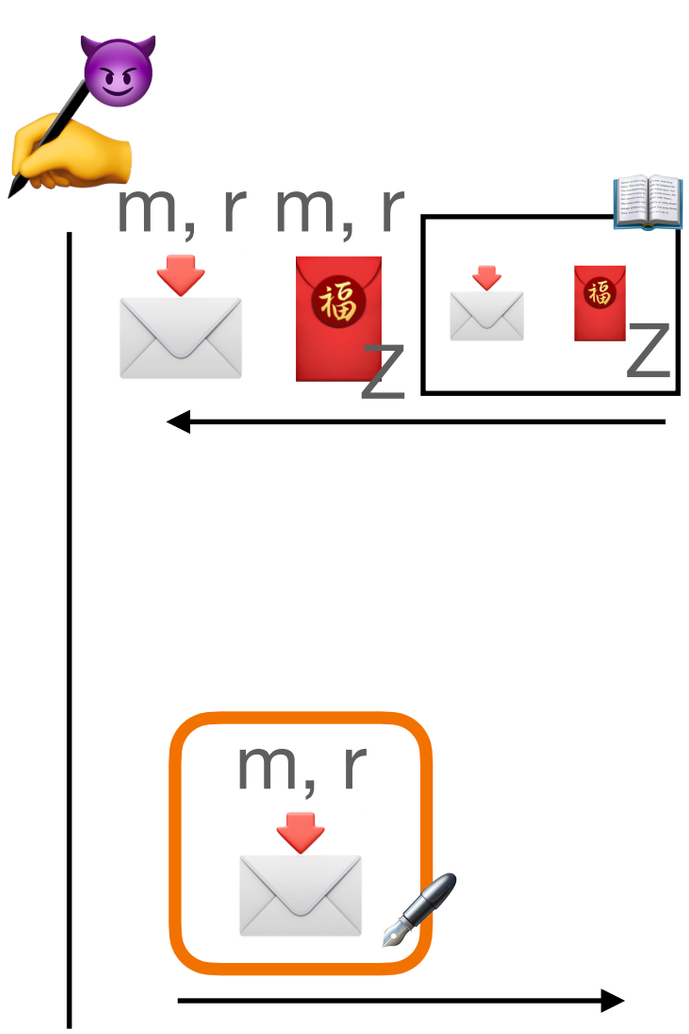
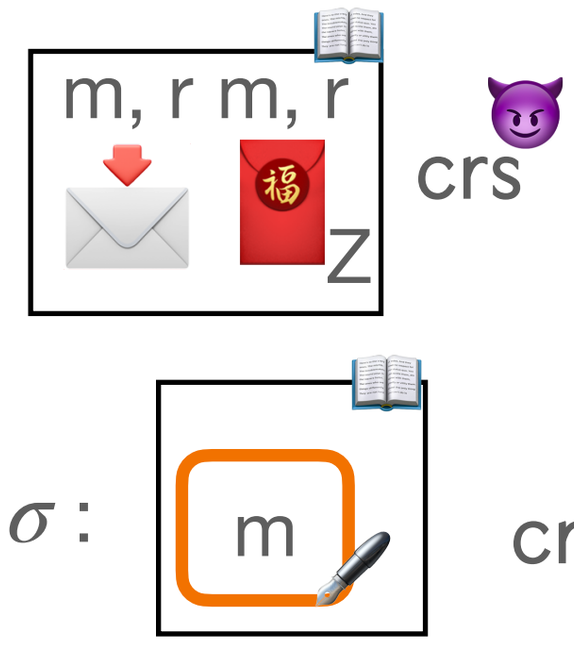
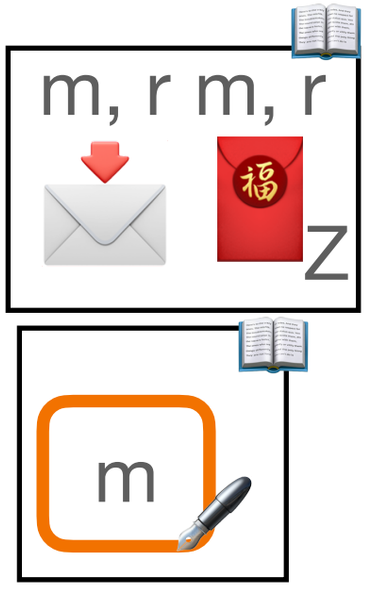




NOT ZK !!



Malicious Blindness (4)

NIZKs Not ZK - Solution

Subversion-ZK in ROM: 😈

1. ZK stills holds with crs
2. ROM to embed
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Malicious Blindness (4)

NIZKs Not ZK - Solution

Subversion-ZK in ROM: 😈

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unif-rs : prime-order structure for S-ZK in ROM

😈 crs has

😈 struct-rs link the different orders of the groups, e.g. 📩 in $\mathbb{Z}_N^*$, 🧧 Z in $\mathbb{G}$;

Also, we can use efficient RSA-based RPs.

Malicious Blindness (4)

NIZKs Not ZK - Solution

Relaxed Range Proofs w/ Subversion-ZK

Subversion-ZK in ROM: 😈

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Conclusion

New Blind Signatures:

- *Round-Optimal*
- *Blindness Against Malicious Signers*
- *In ROM from DDH & sRSA*

Conclusion

New Blind Signatures:

- *Round-Optimal*
- *Blindness Against Malicious Signers*
- *In ROM from DDH & sRSA*

1. *Reduce vk's size?*
2. *Better efficiency?*
3. *Remove the need of sRSA?*
4. *Non-hybrid constructions?*