Round-Optimal Black-Box Multiparty Computation from Polynomial-Time Assumptions

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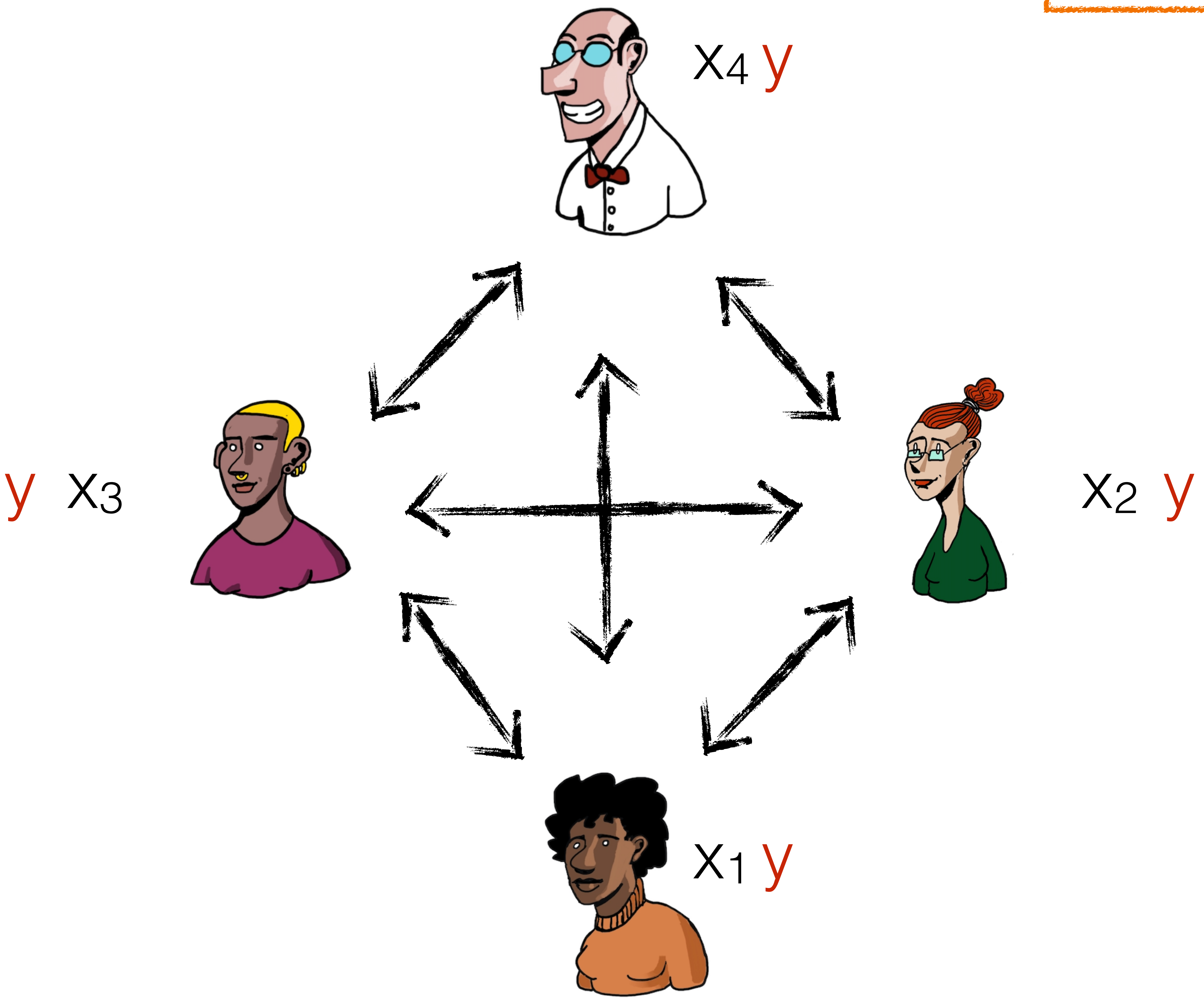
Technical University of Denmark

Hendrik Waldner

Multi-Party Computation (MPC)

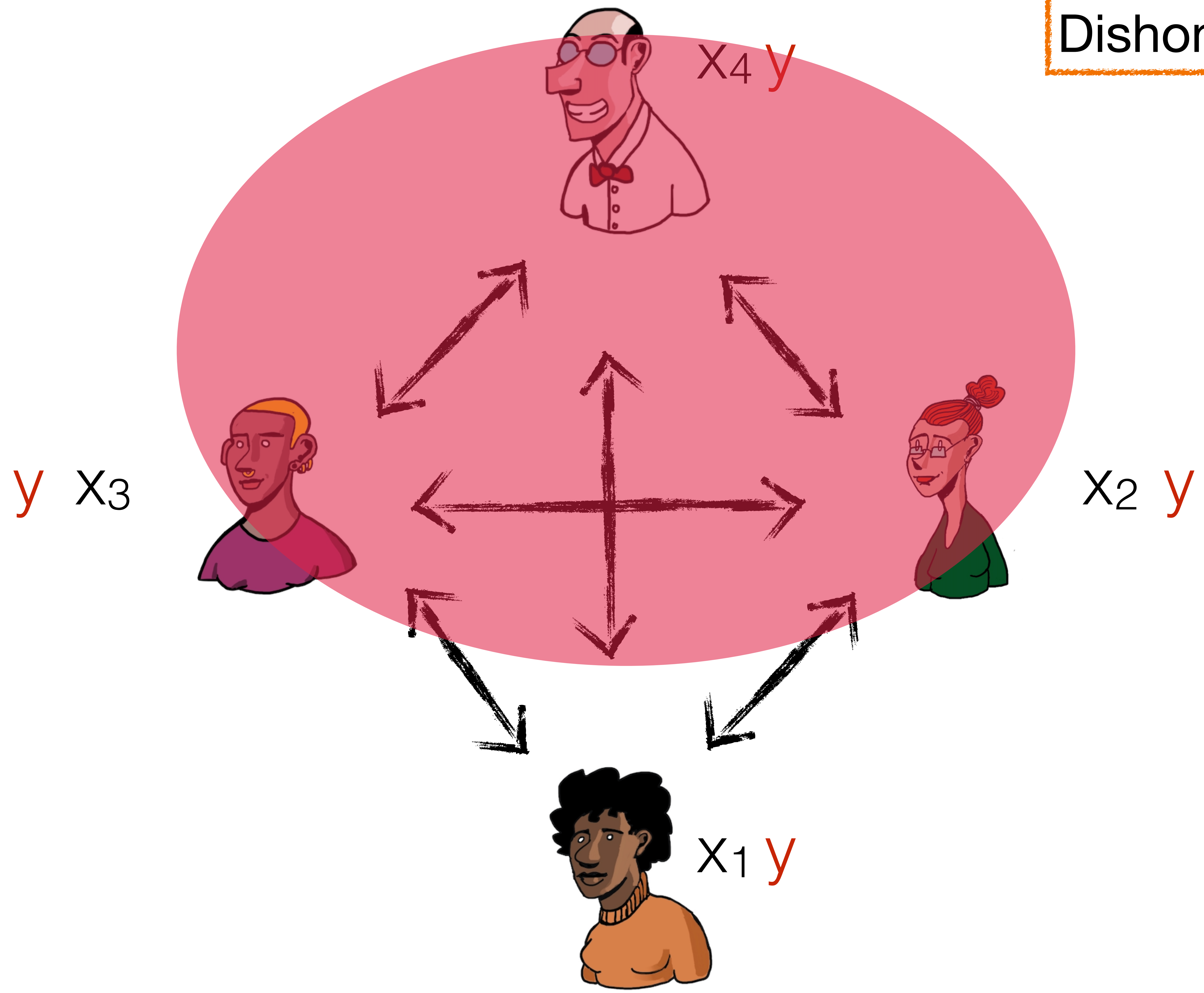
Plain model (no RO, no setup)



$y=f(x_1,x_2,x_3,x_4)$

Multi-Party Computation (MPC)

Plain model (no RO, no setup)
Dishonest majority



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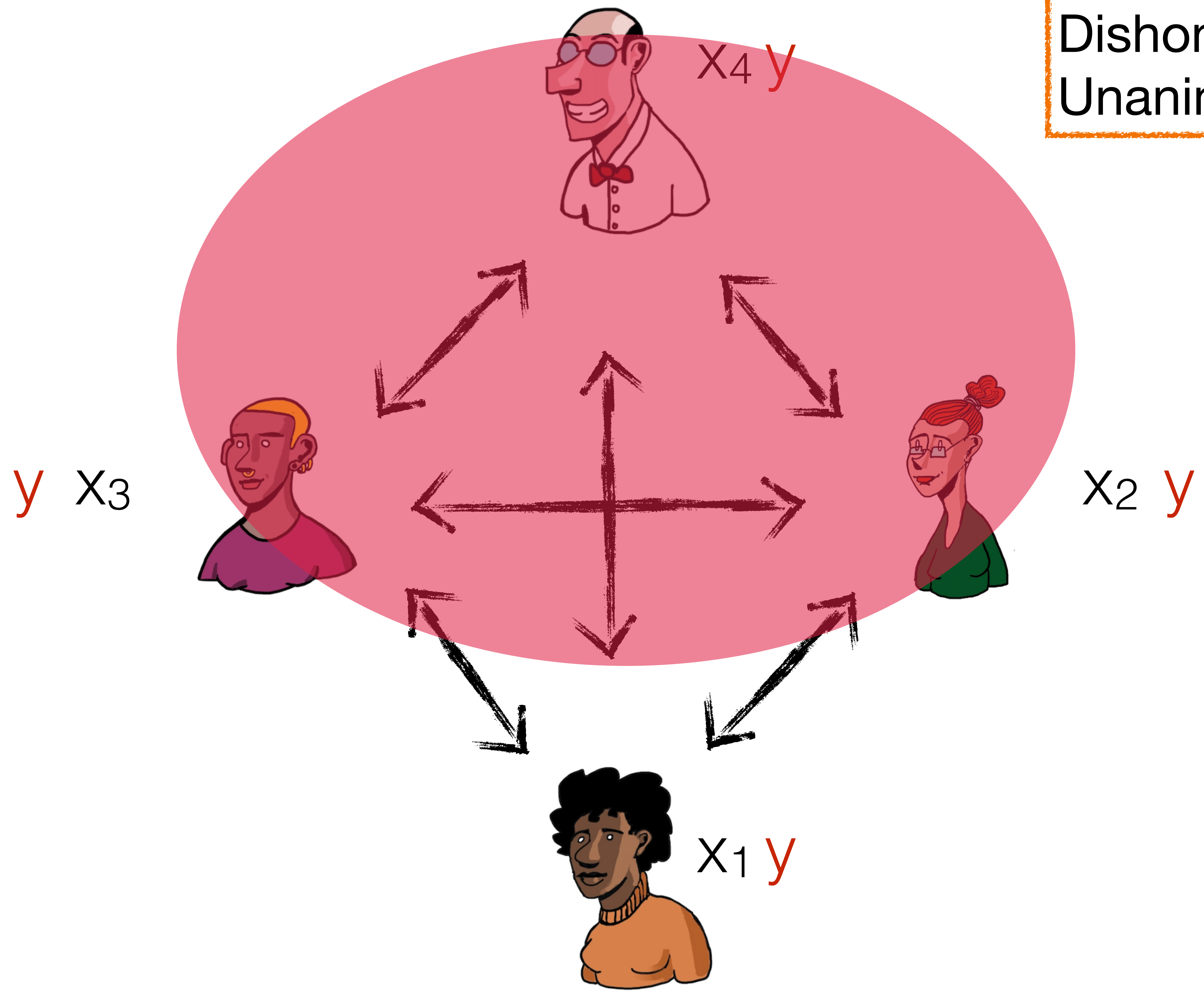
Unanimous abort



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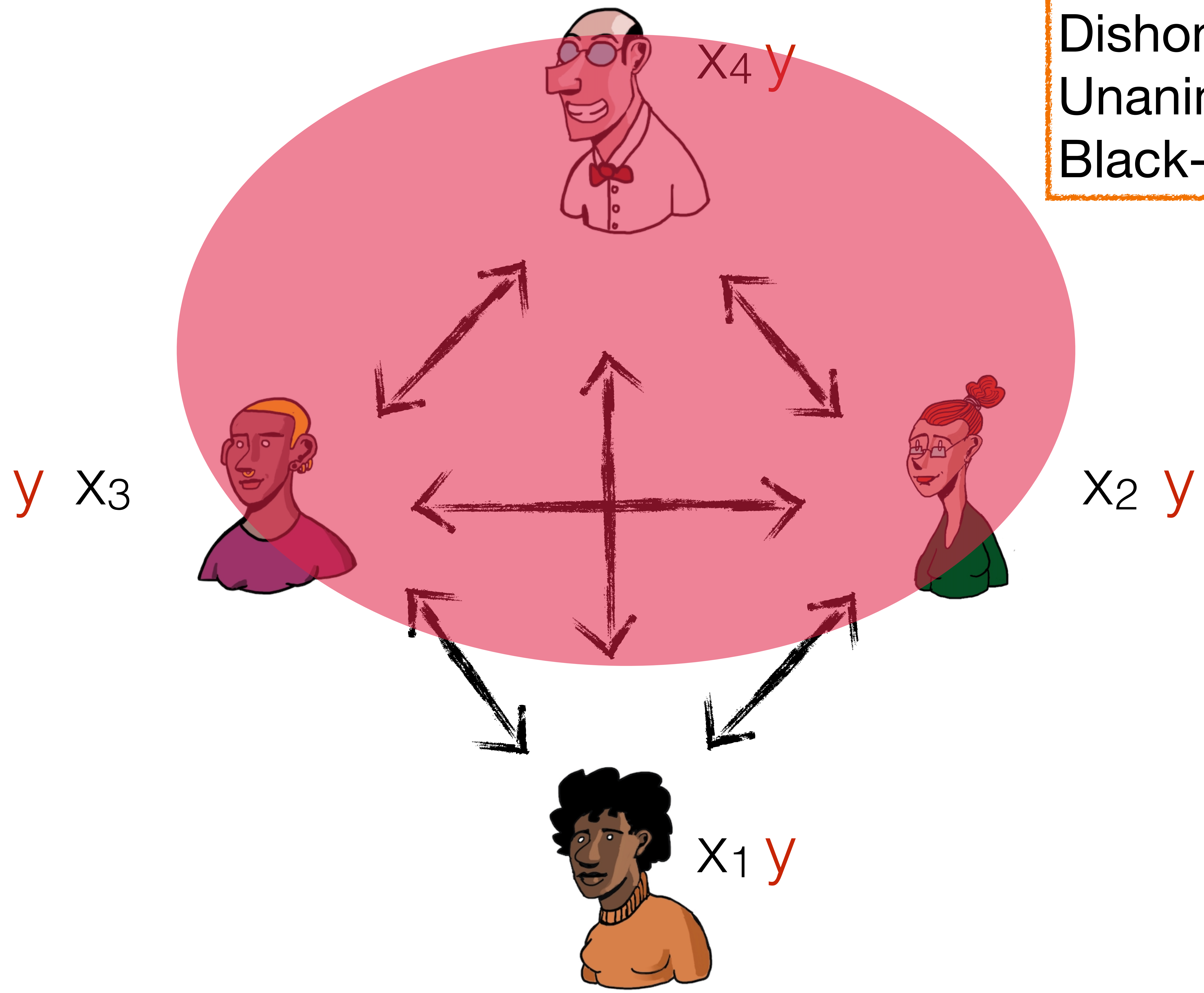
Black-box simulation



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What is the exact round complexity?

The State of the Art on Round Optimal MPC

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Optimal round complexity: 4-round [GK90, KO04, GMPP16]

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. . .

[BGJ+18]
[HHPV18]

4 ROUND
Num. ass.

[CCG+20]

4 ROUND
OT

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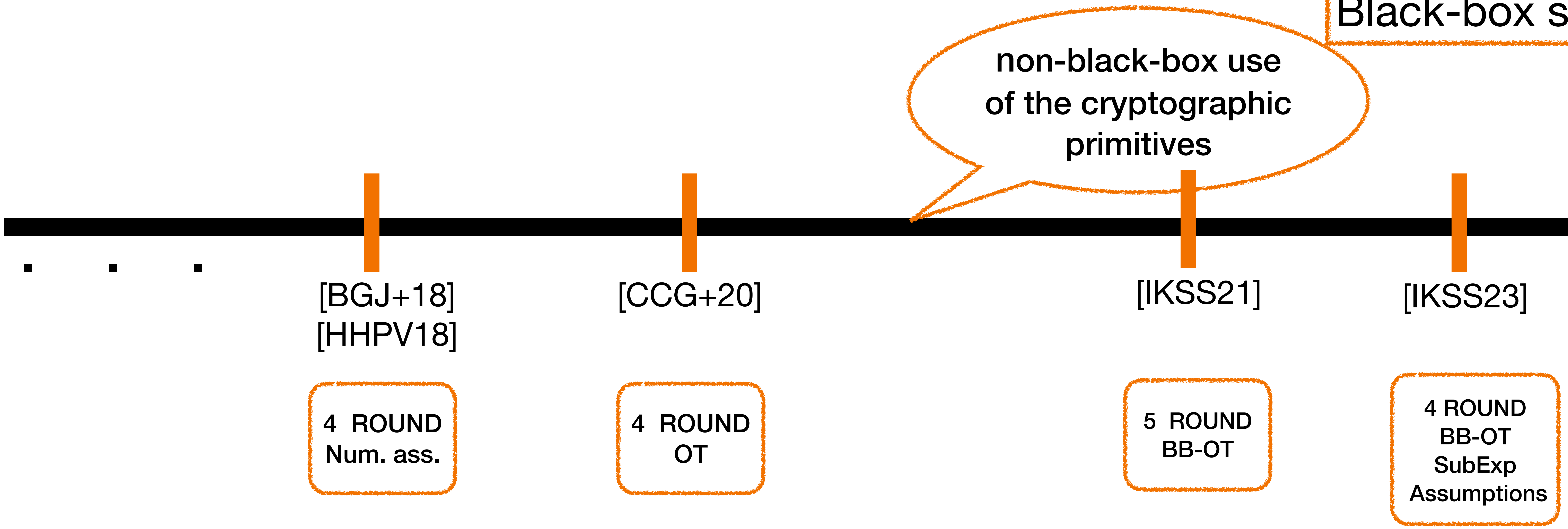

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non-black-box use of the cryptographic primitives

. . .

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[IKSS21]

5 ROUND
BB-OT

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SubExp
Assumptions

[COSW23]

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Inputless-functionalities

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Can we close the gap?

[IPS08] Compiler

OUTER PROTOCOL

Secure against (m-1)/3 malicious servers [IKP10]

m Servers

n Clients

[IKP10]Y. Ishai, E. Kushilevitz, and A. Paskin. Secure multiparty computation with minimal interaction. In CRYPTO 2010
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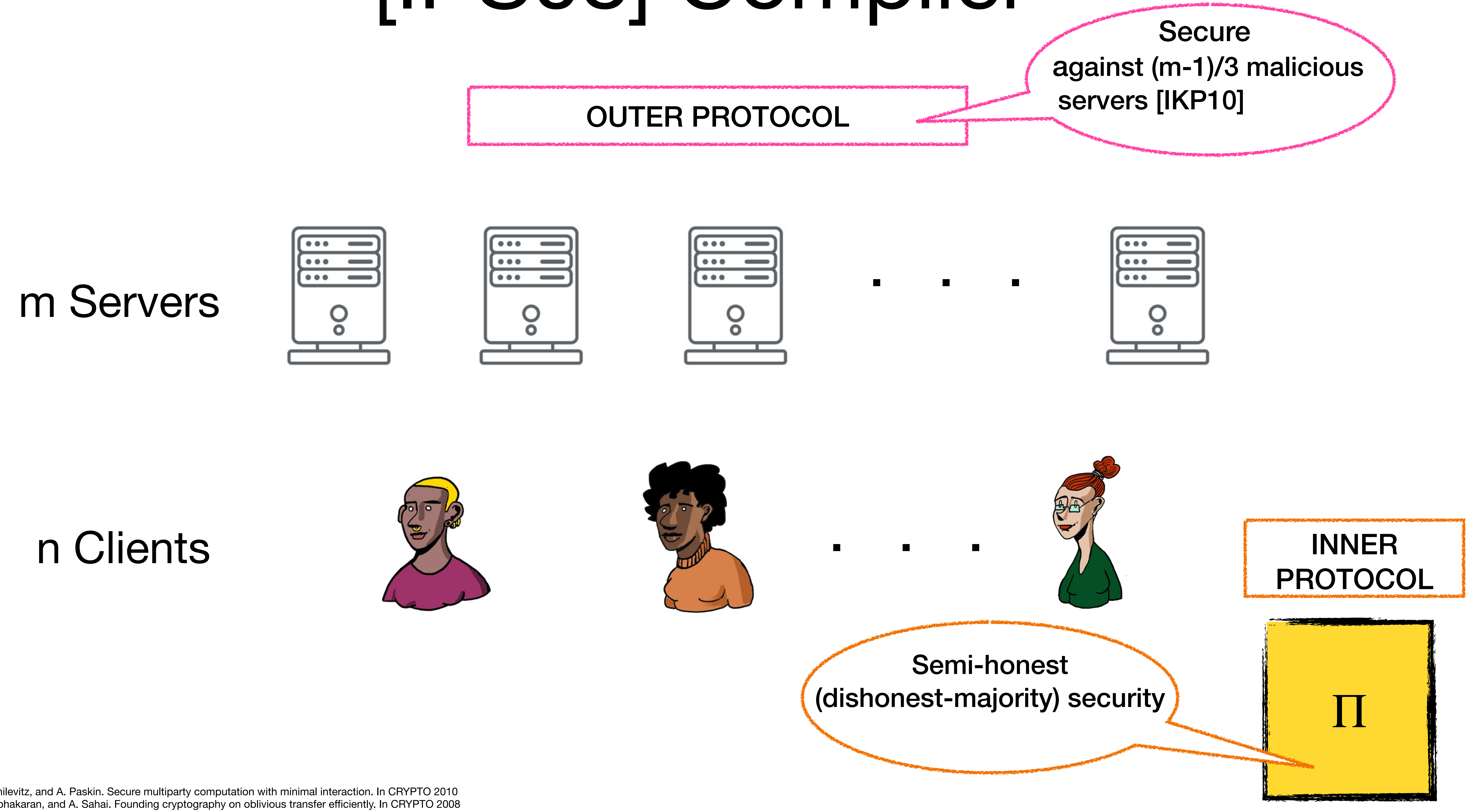

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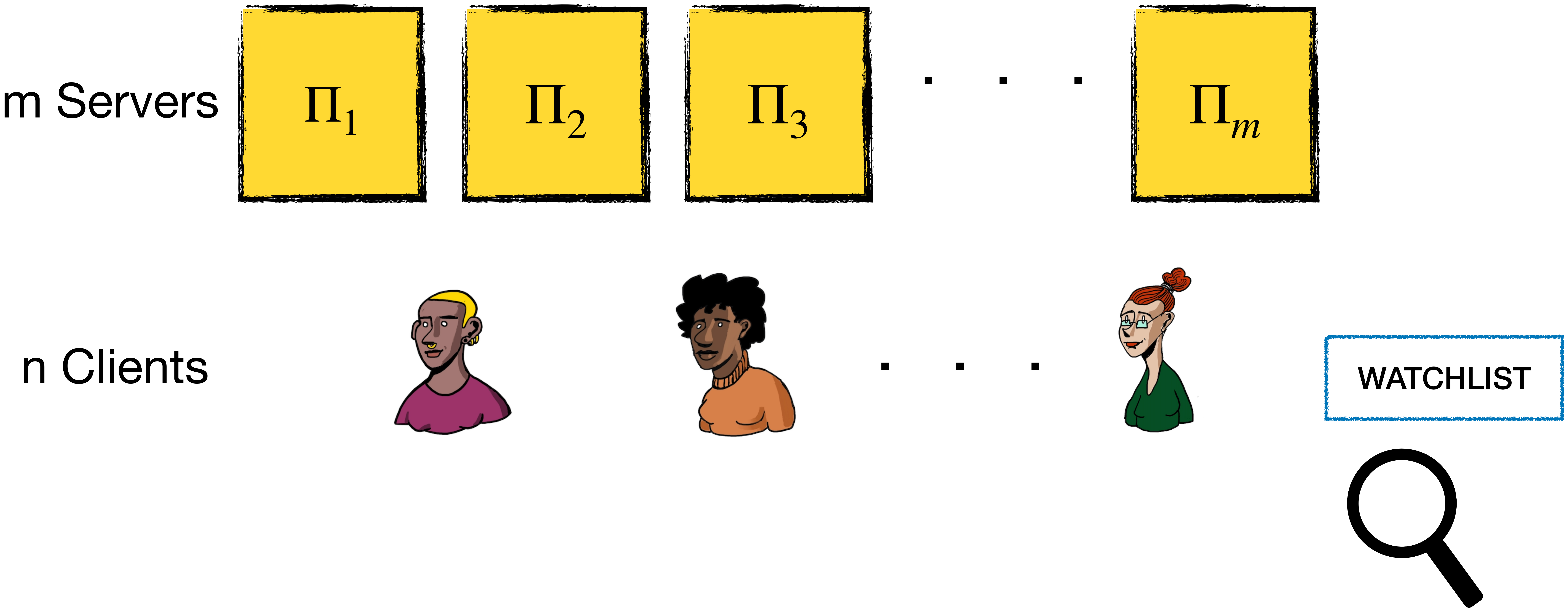

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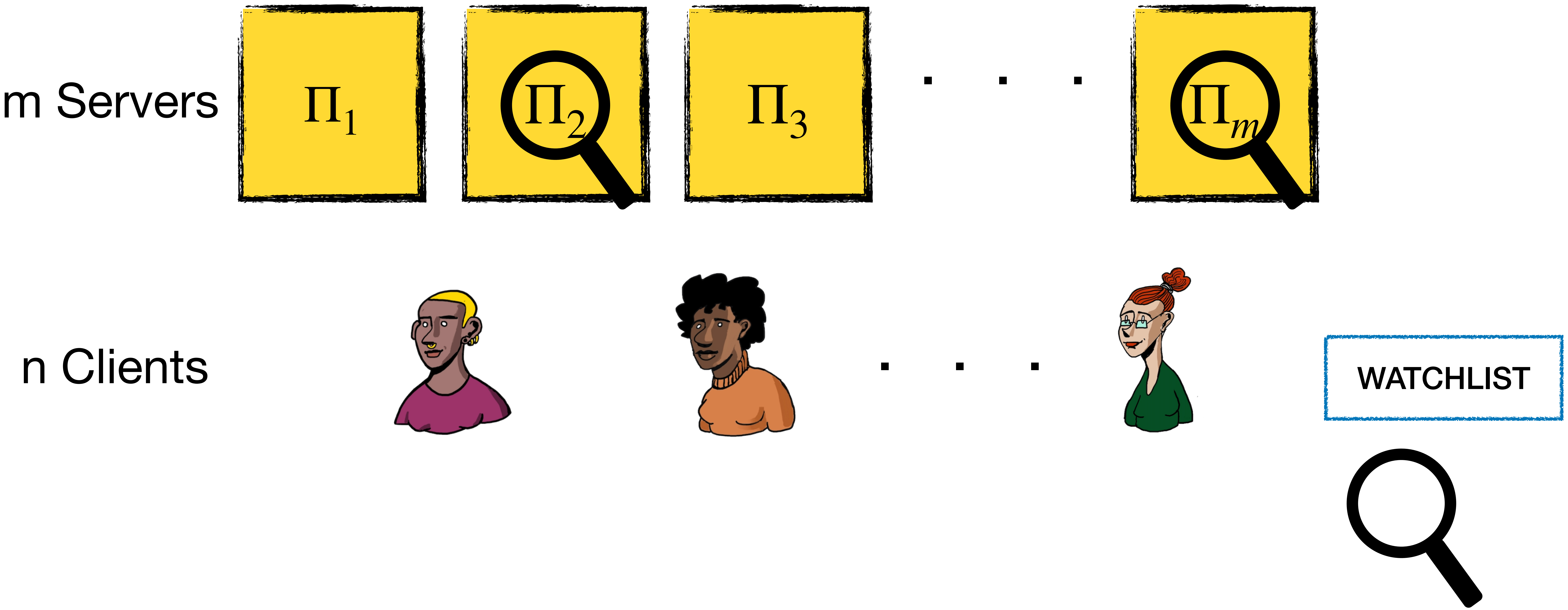

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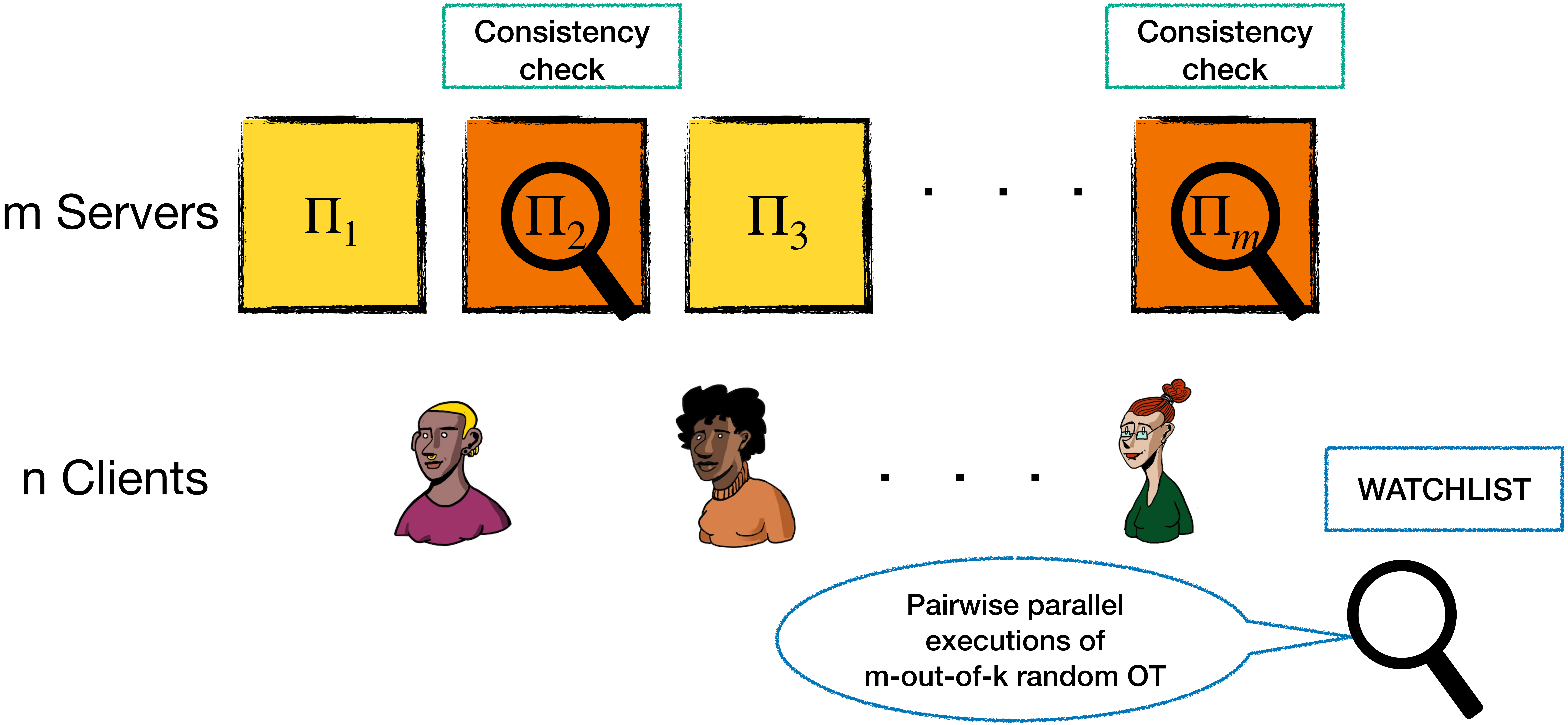

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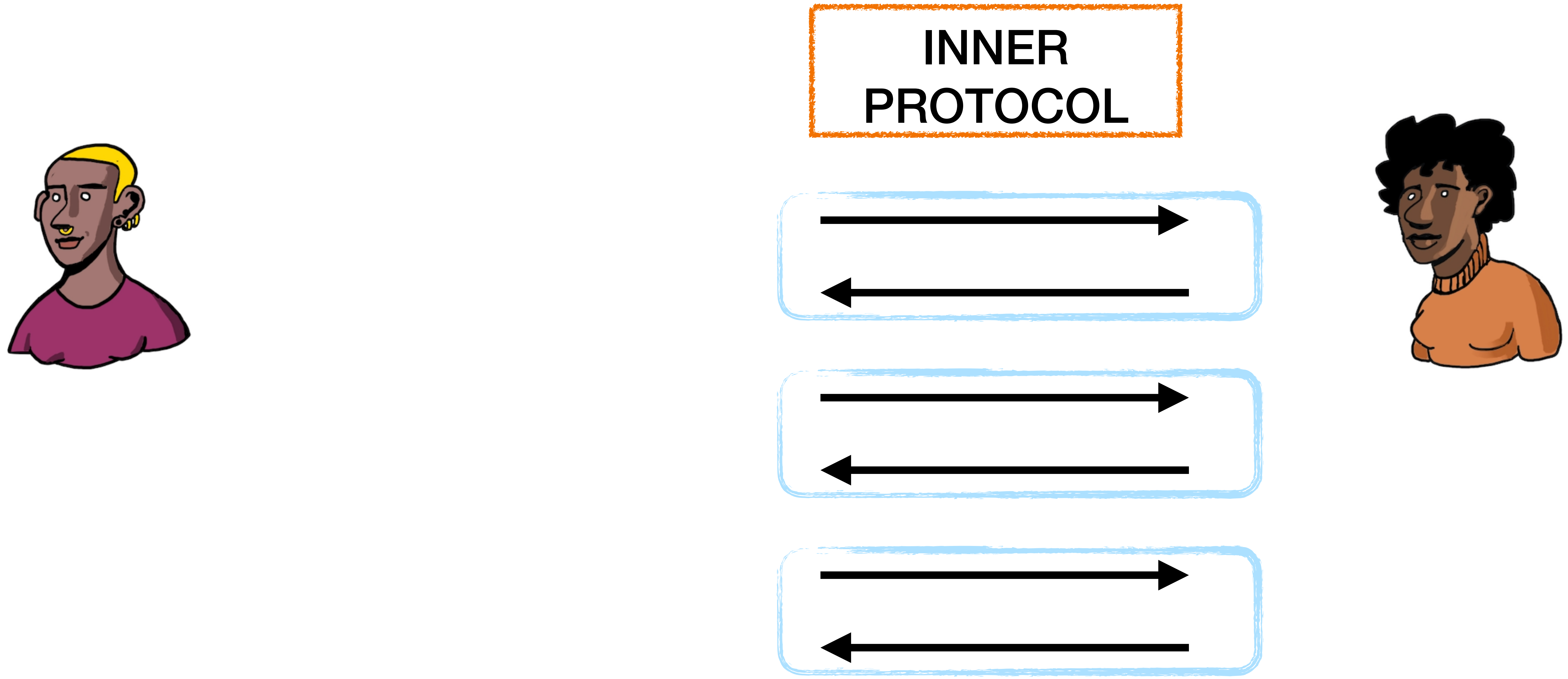

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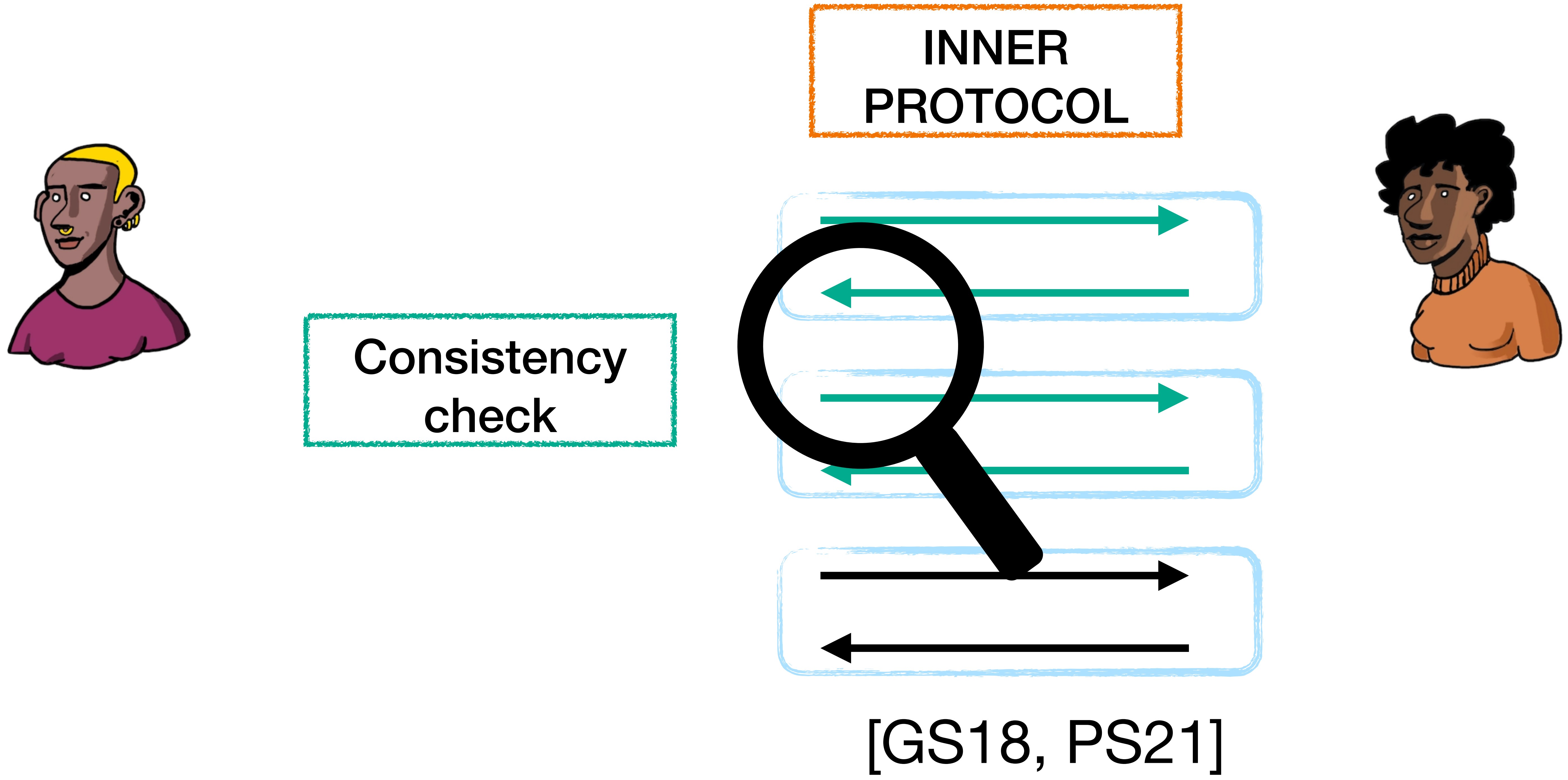

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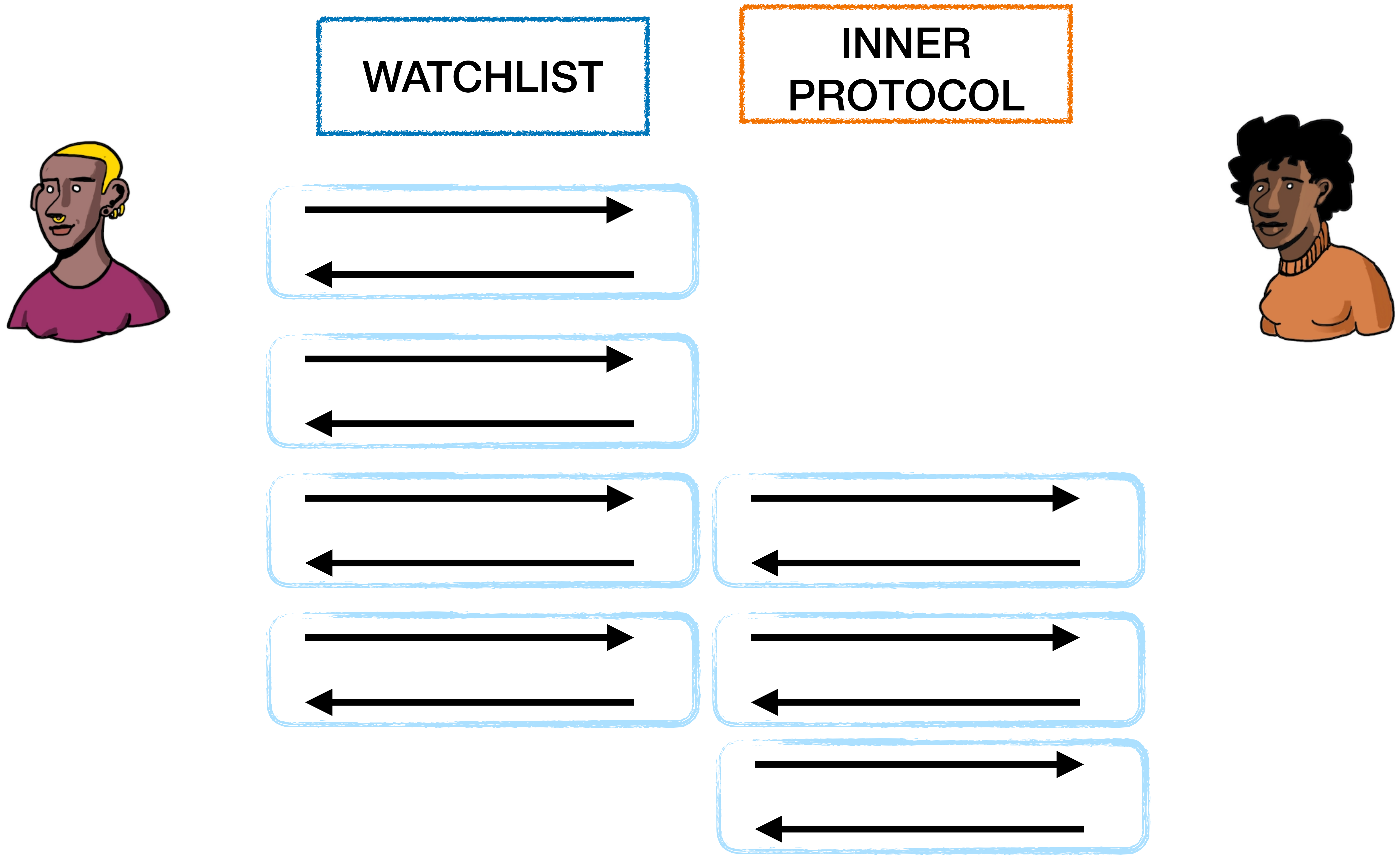

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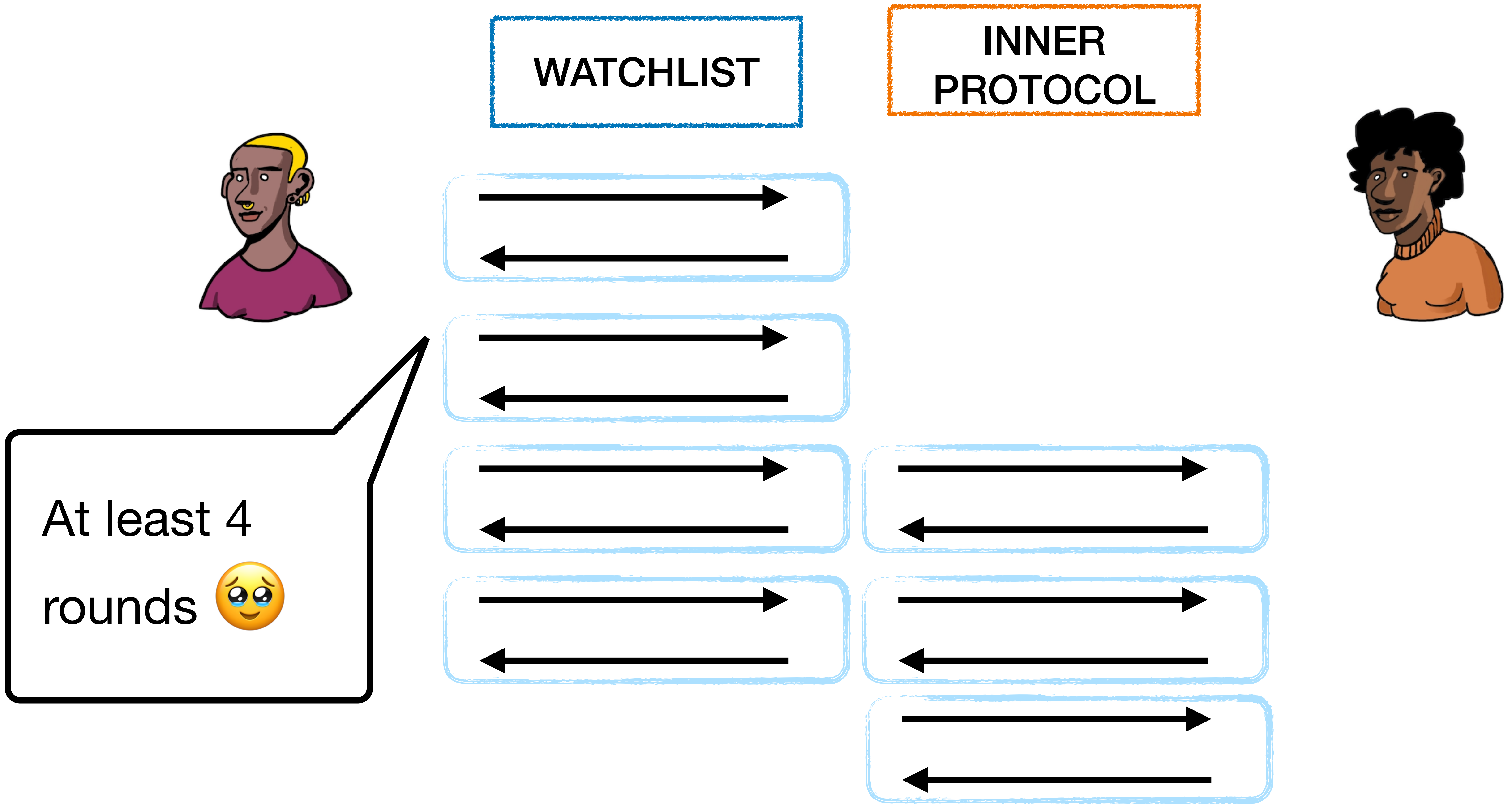

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Sometimes aborting adversaries

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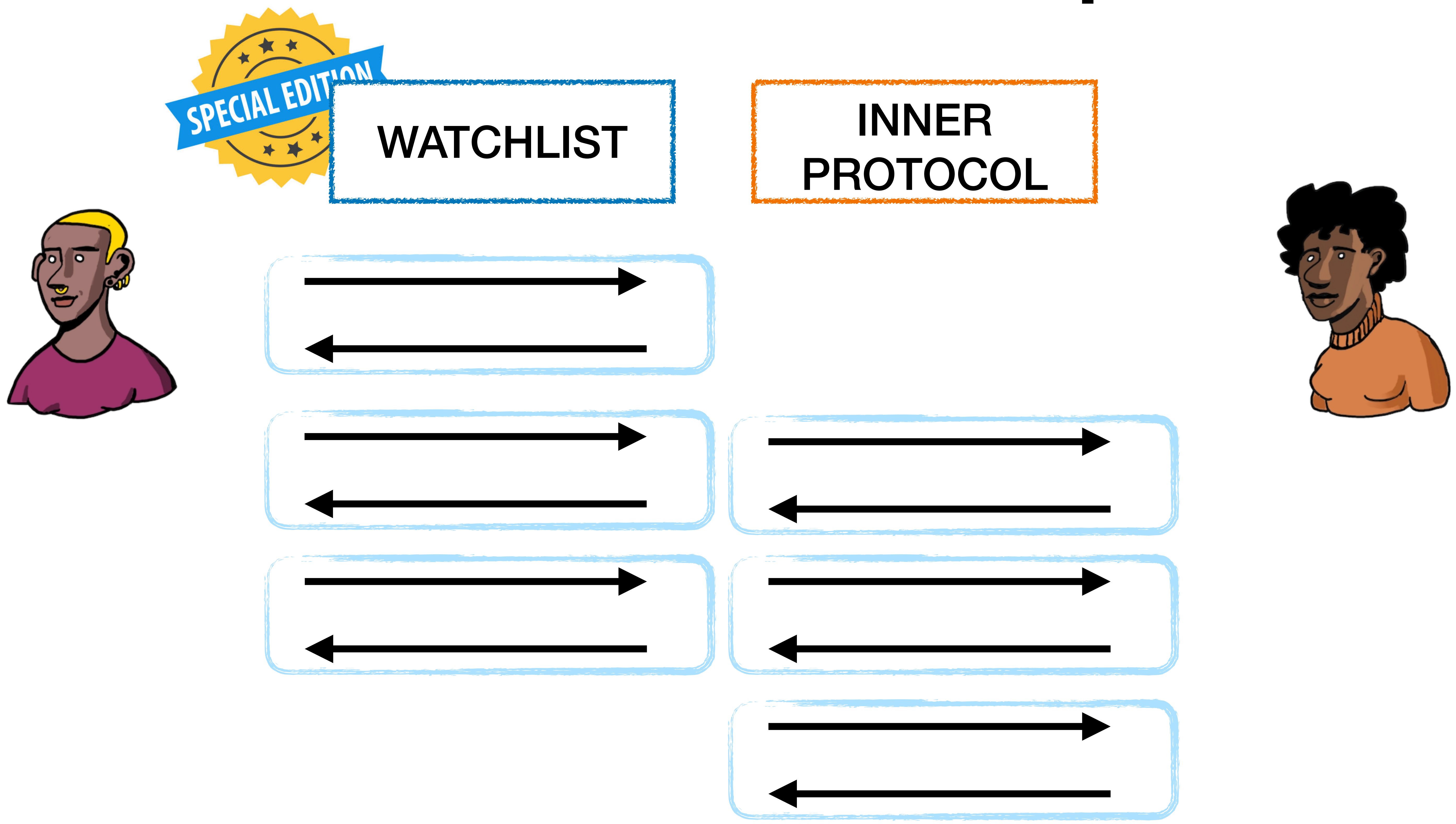

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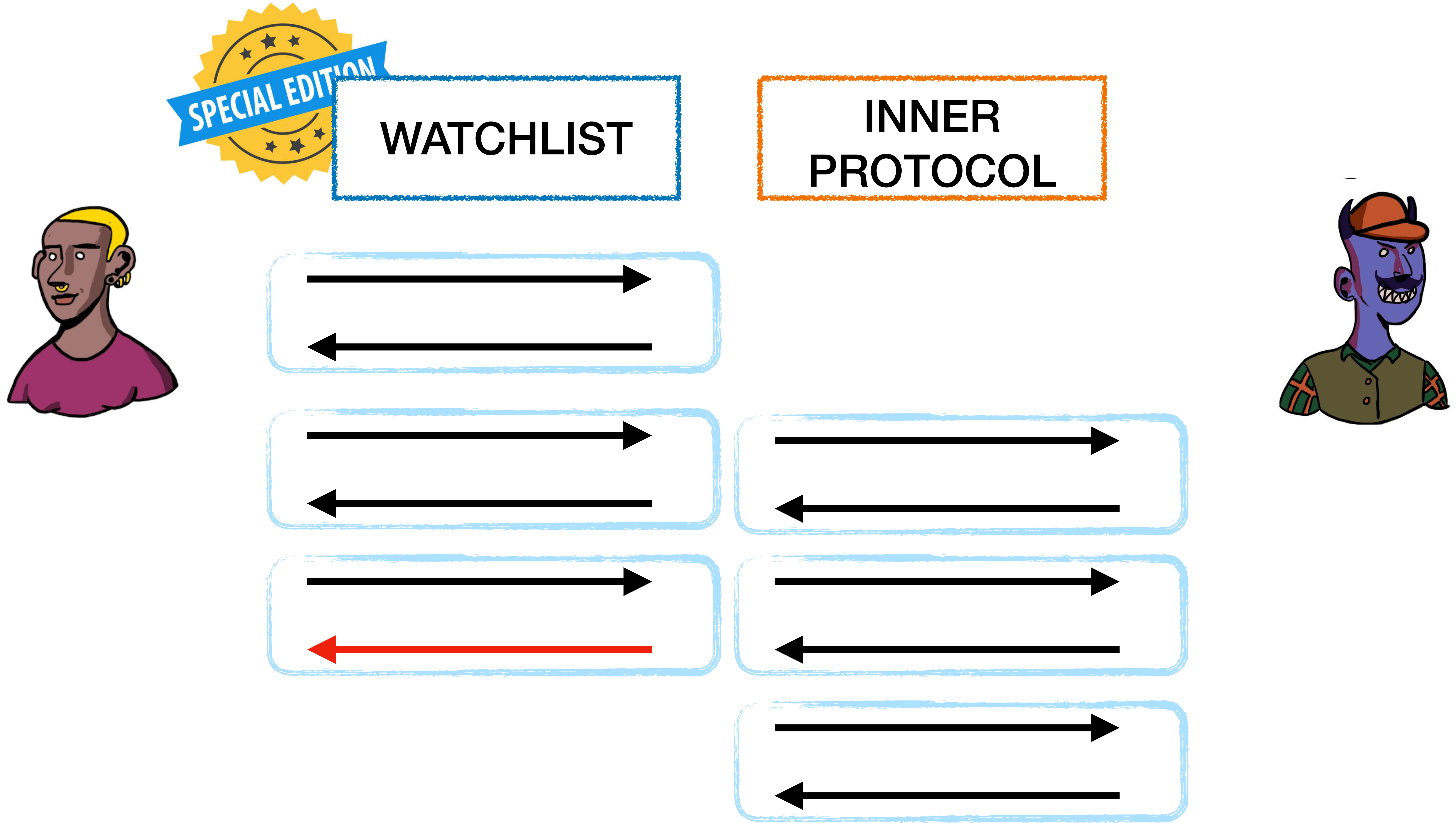

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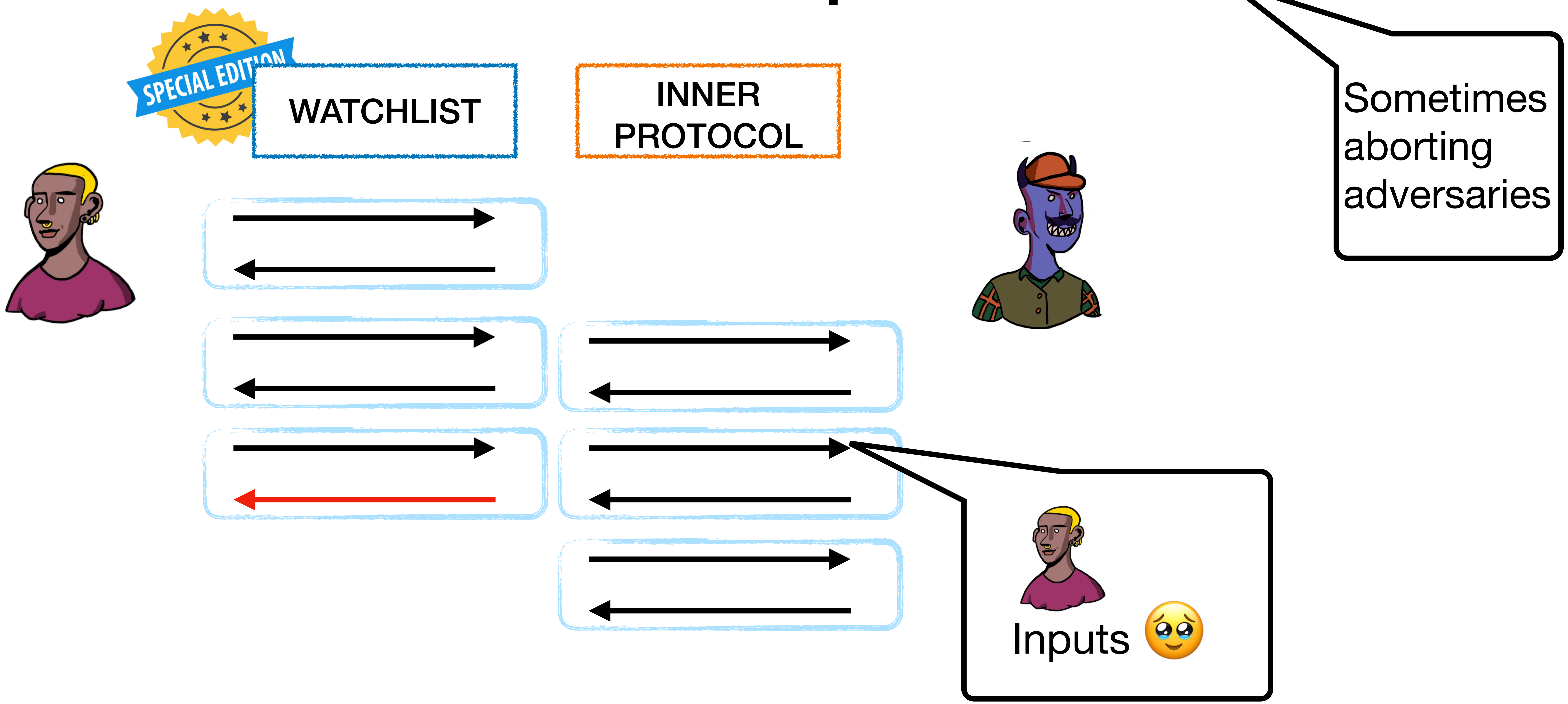

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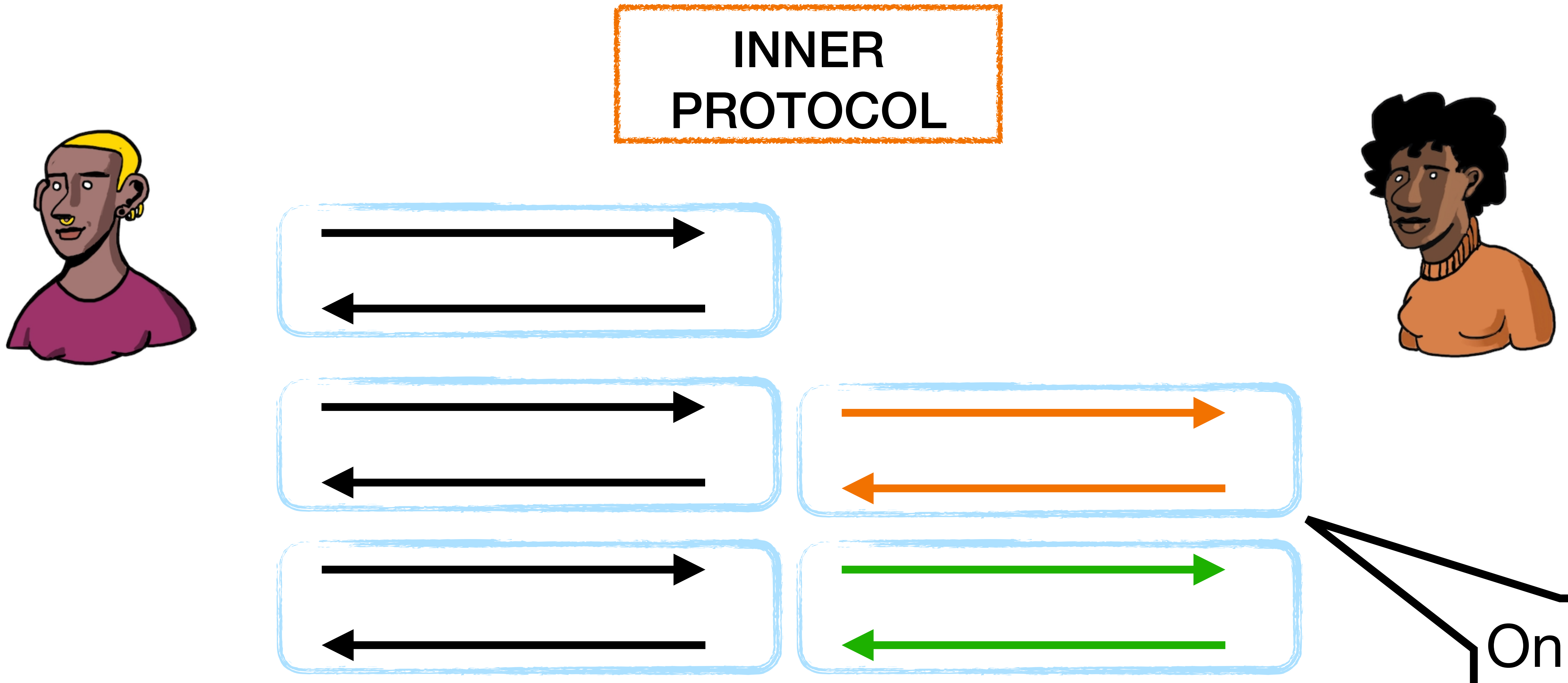
Our Approach: Split Inner Protocol



Only orange and green messages contain parties' inputs [IKSS23, PS21]

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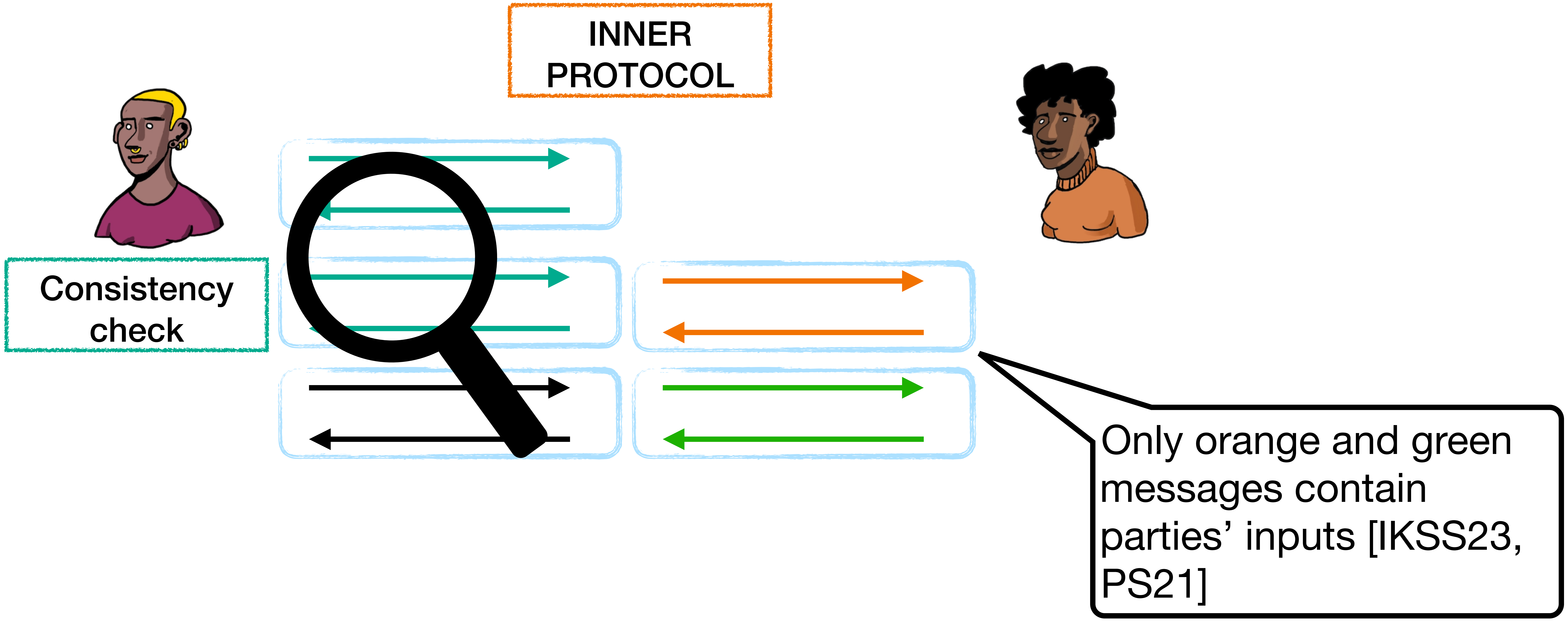

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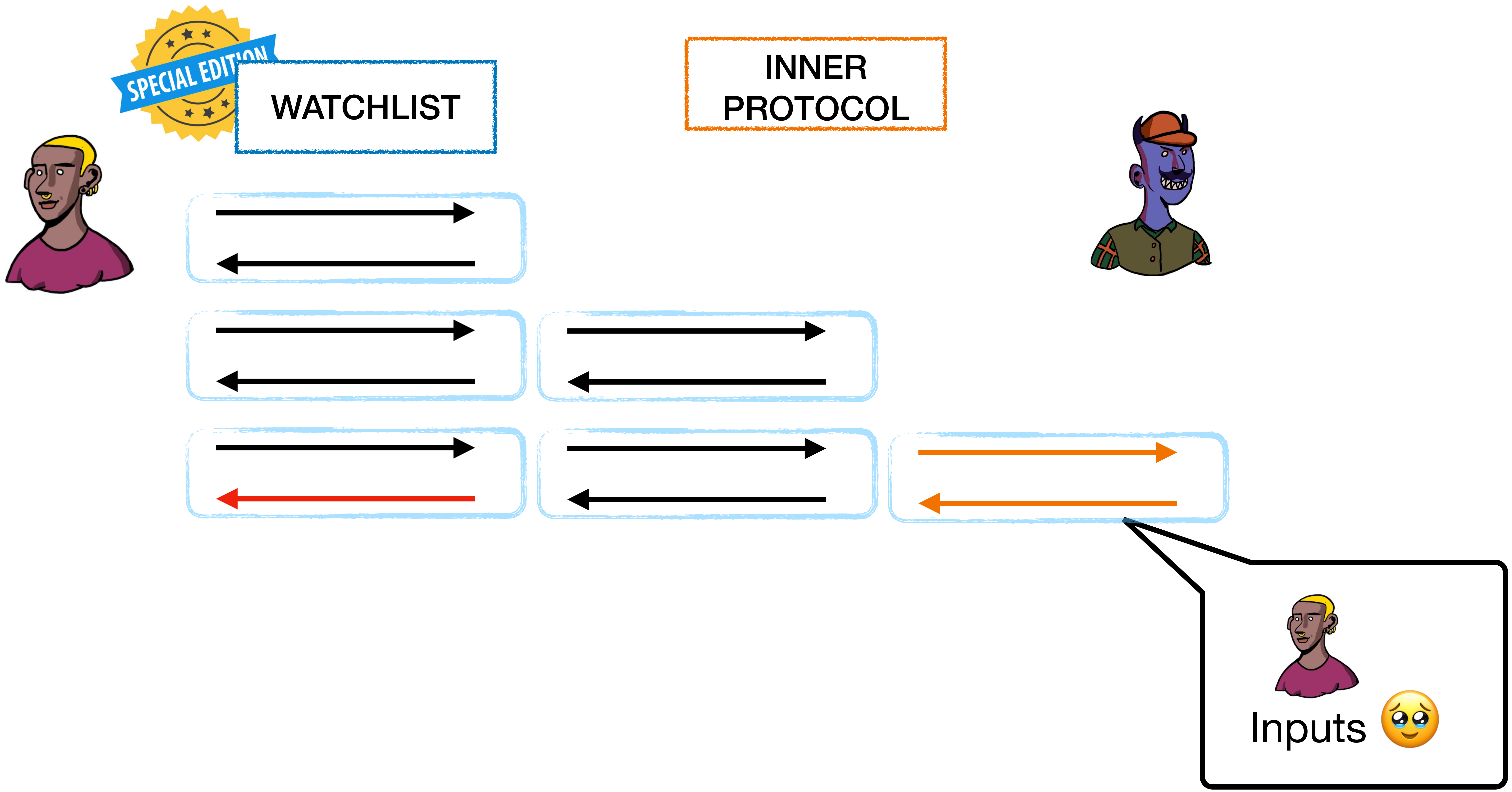
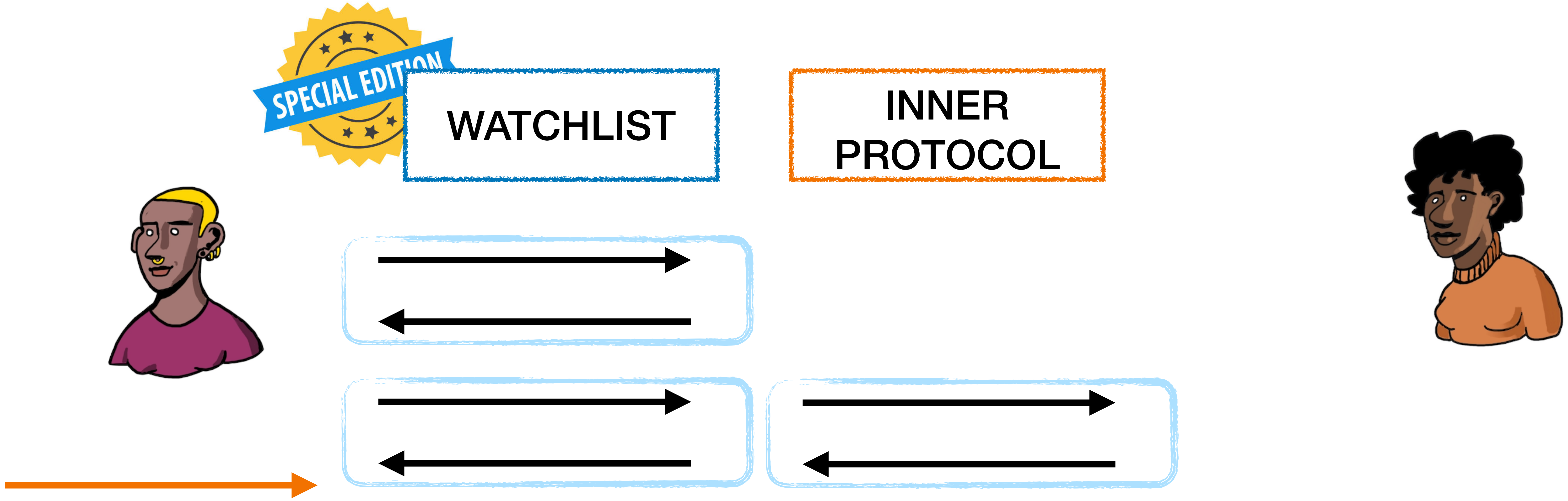


Our Approach: Conditional Disclosure of Secrets



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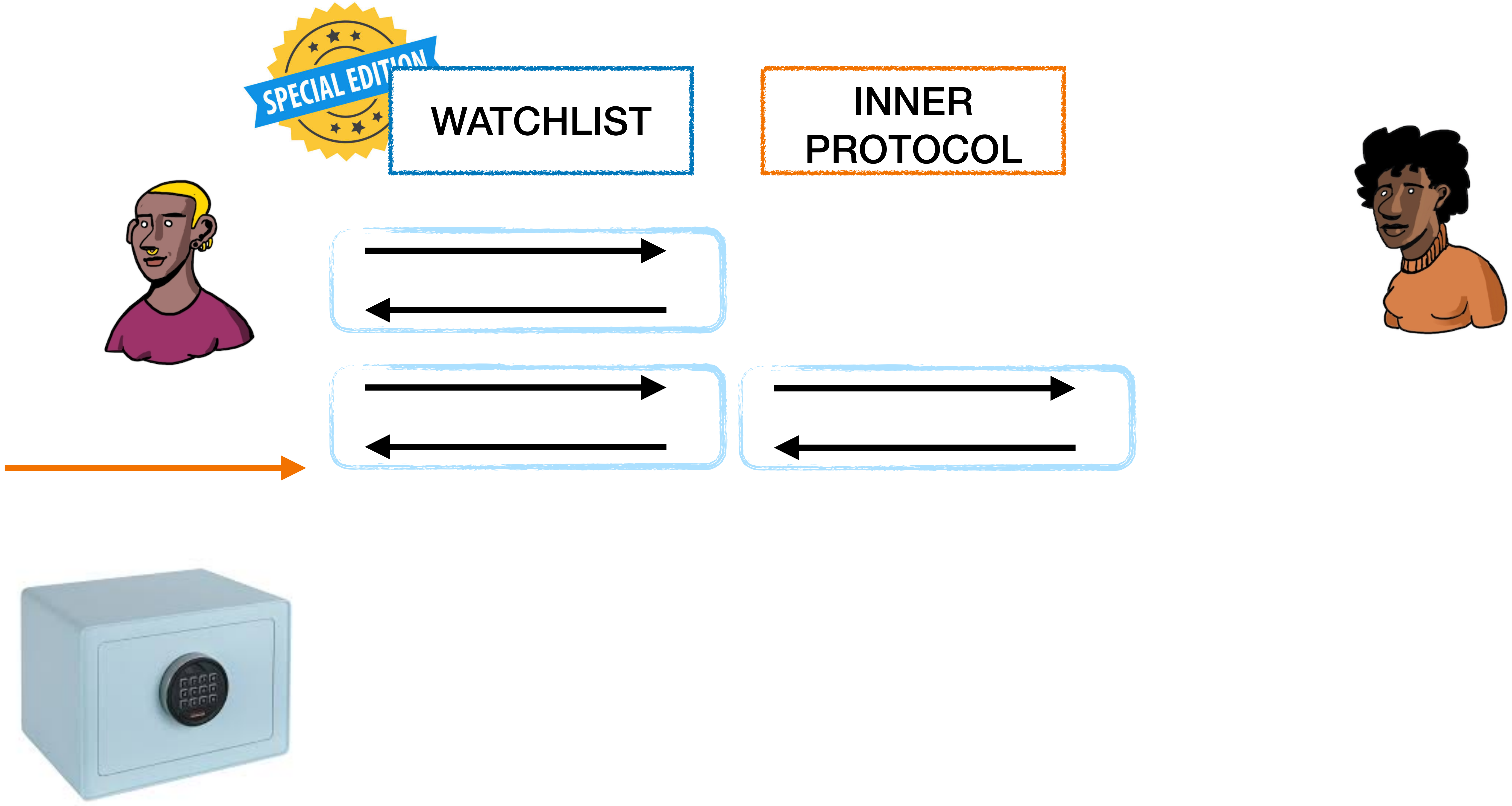

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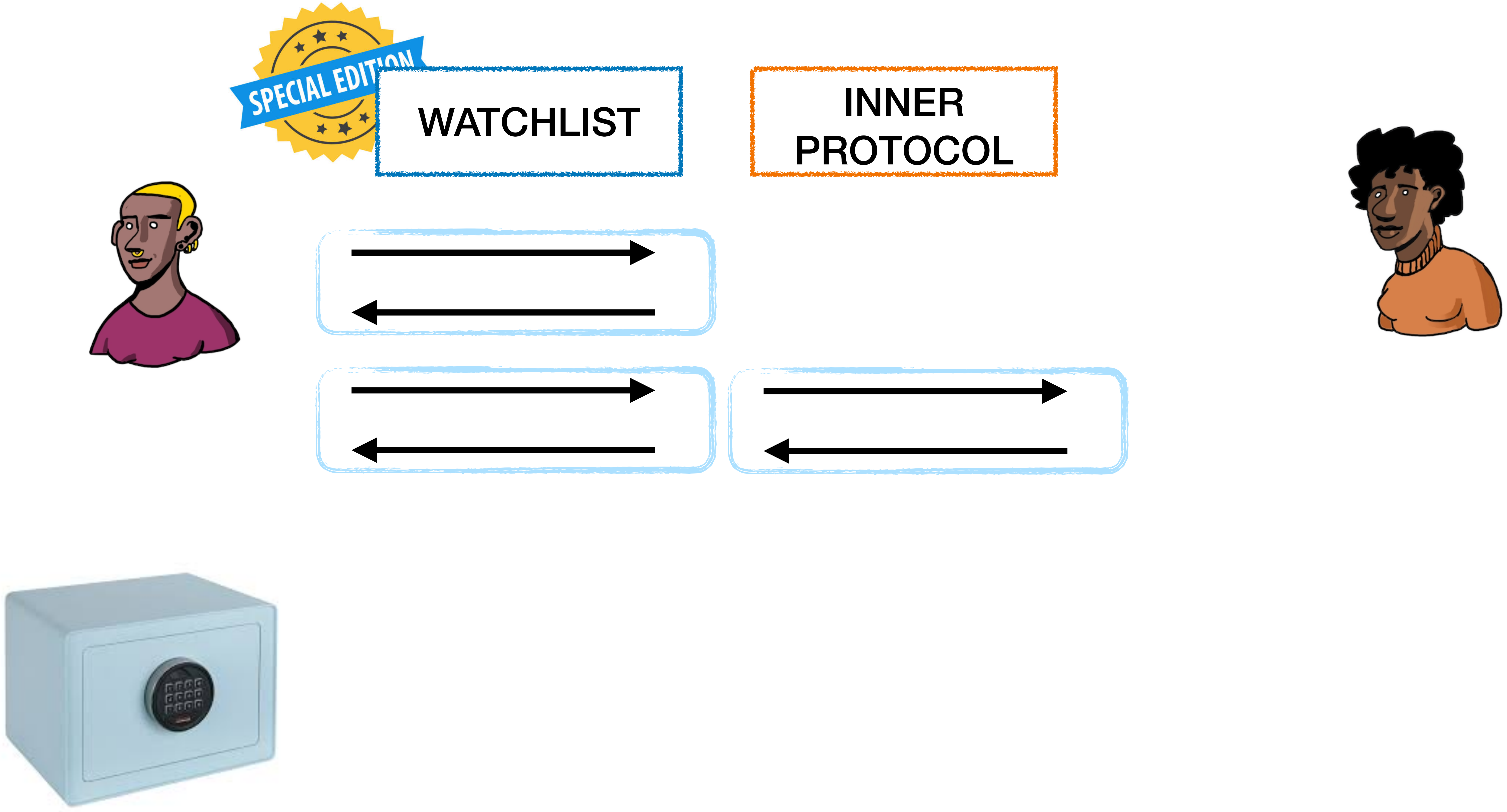

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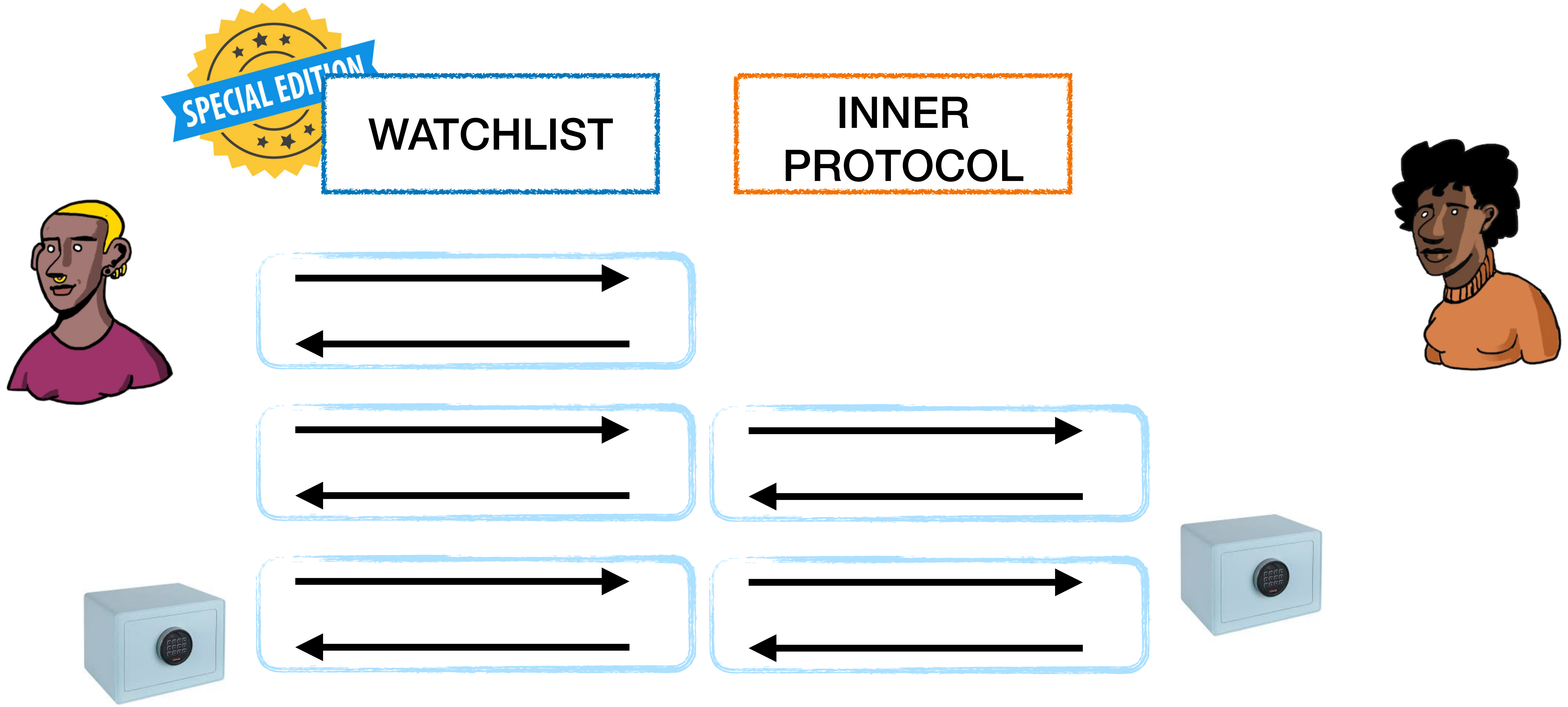

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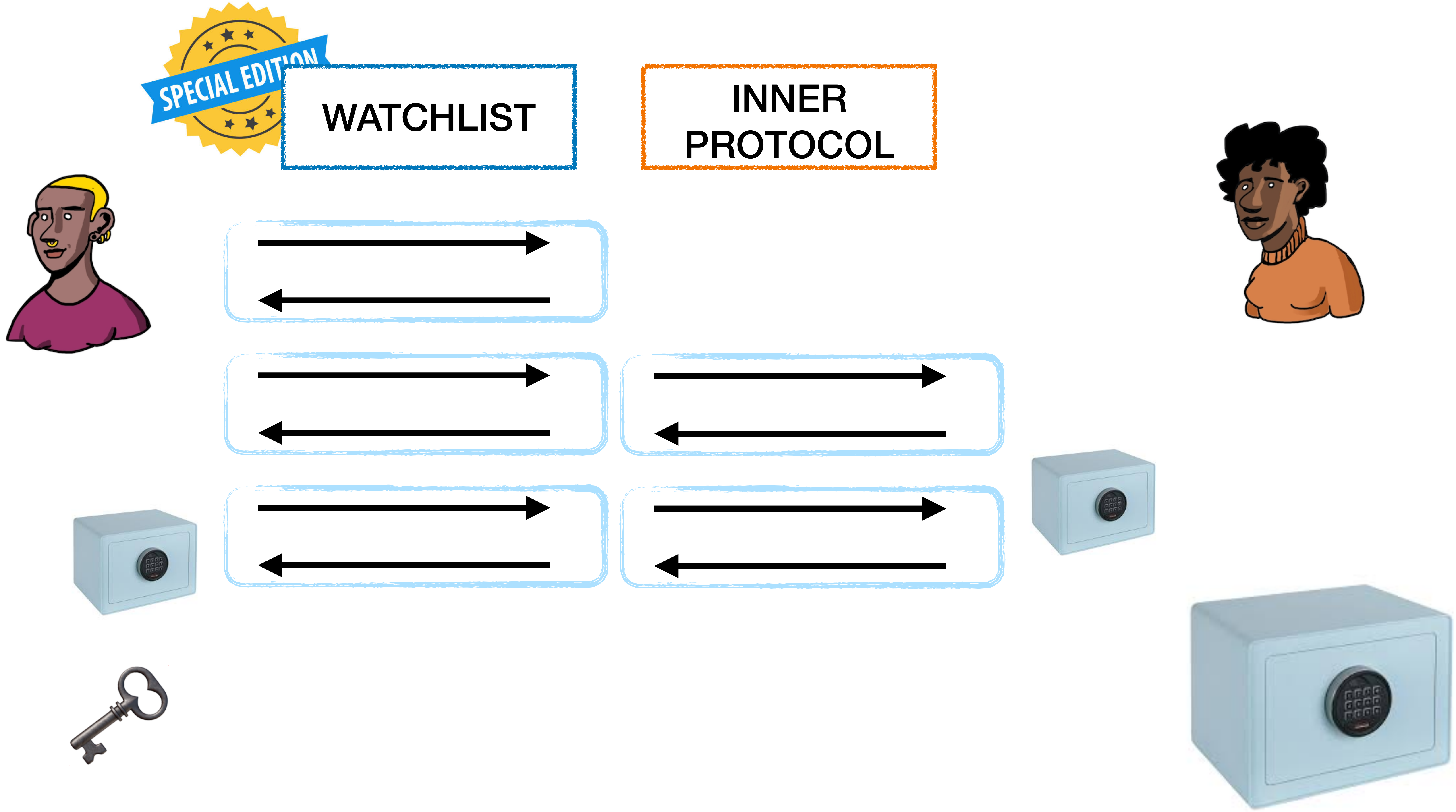

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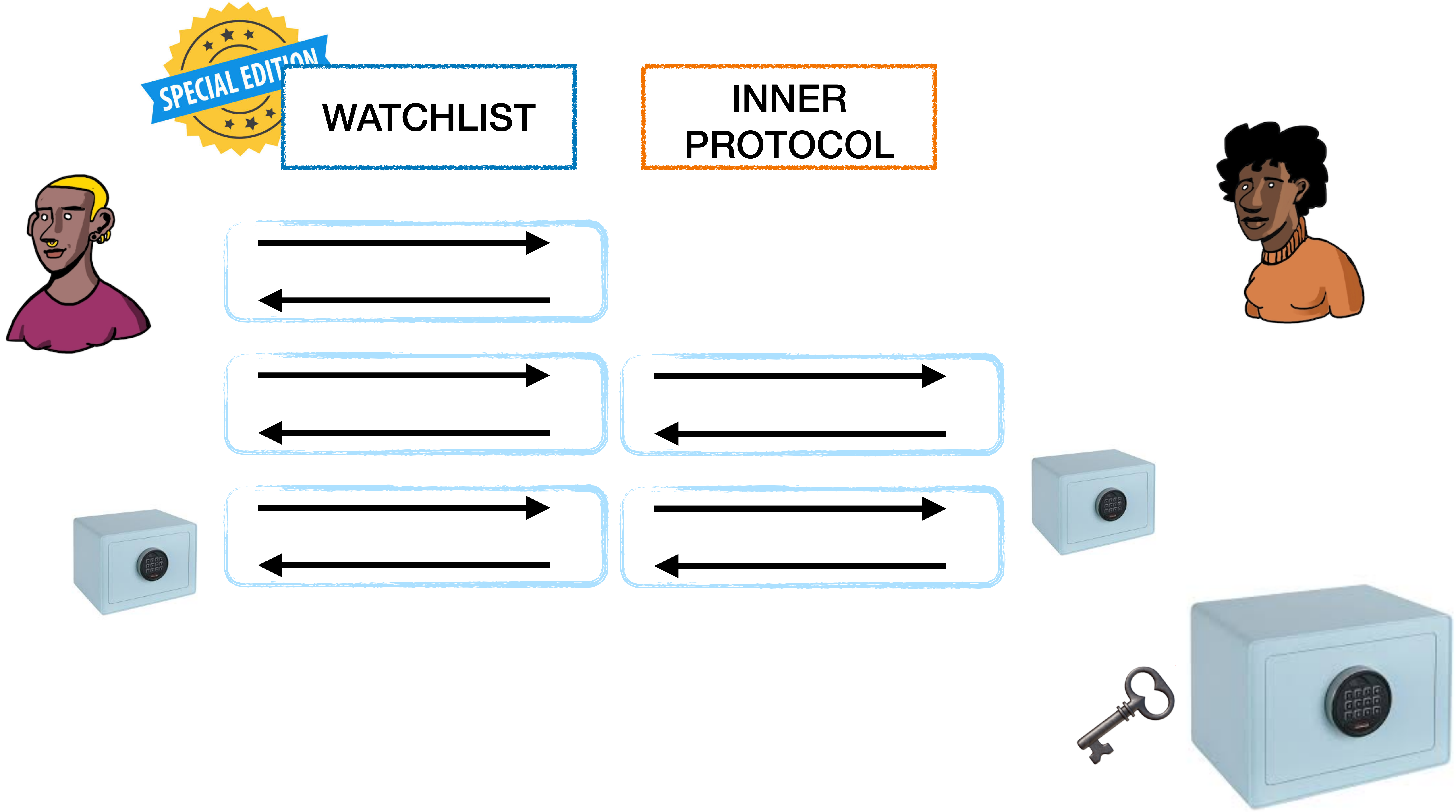

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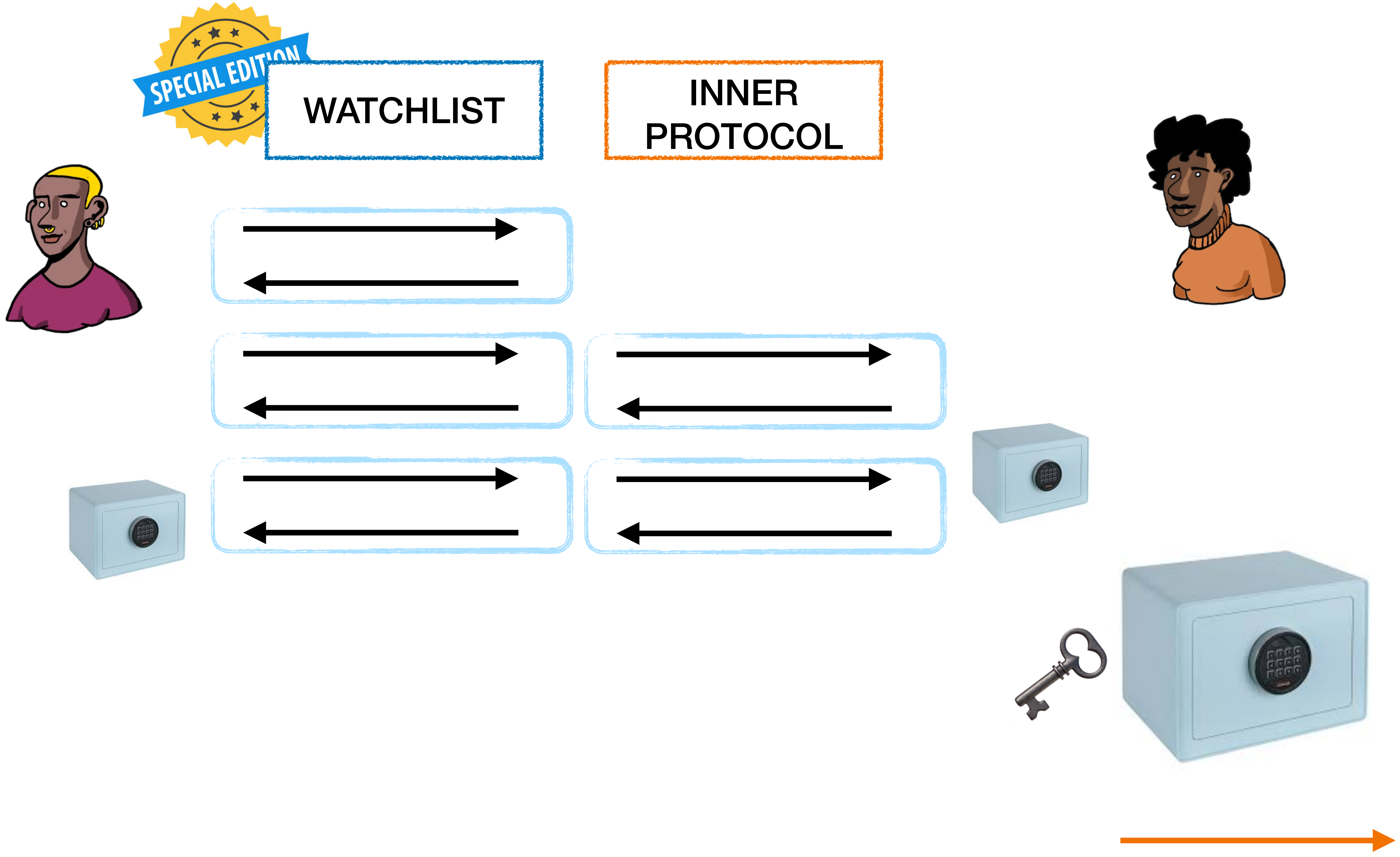

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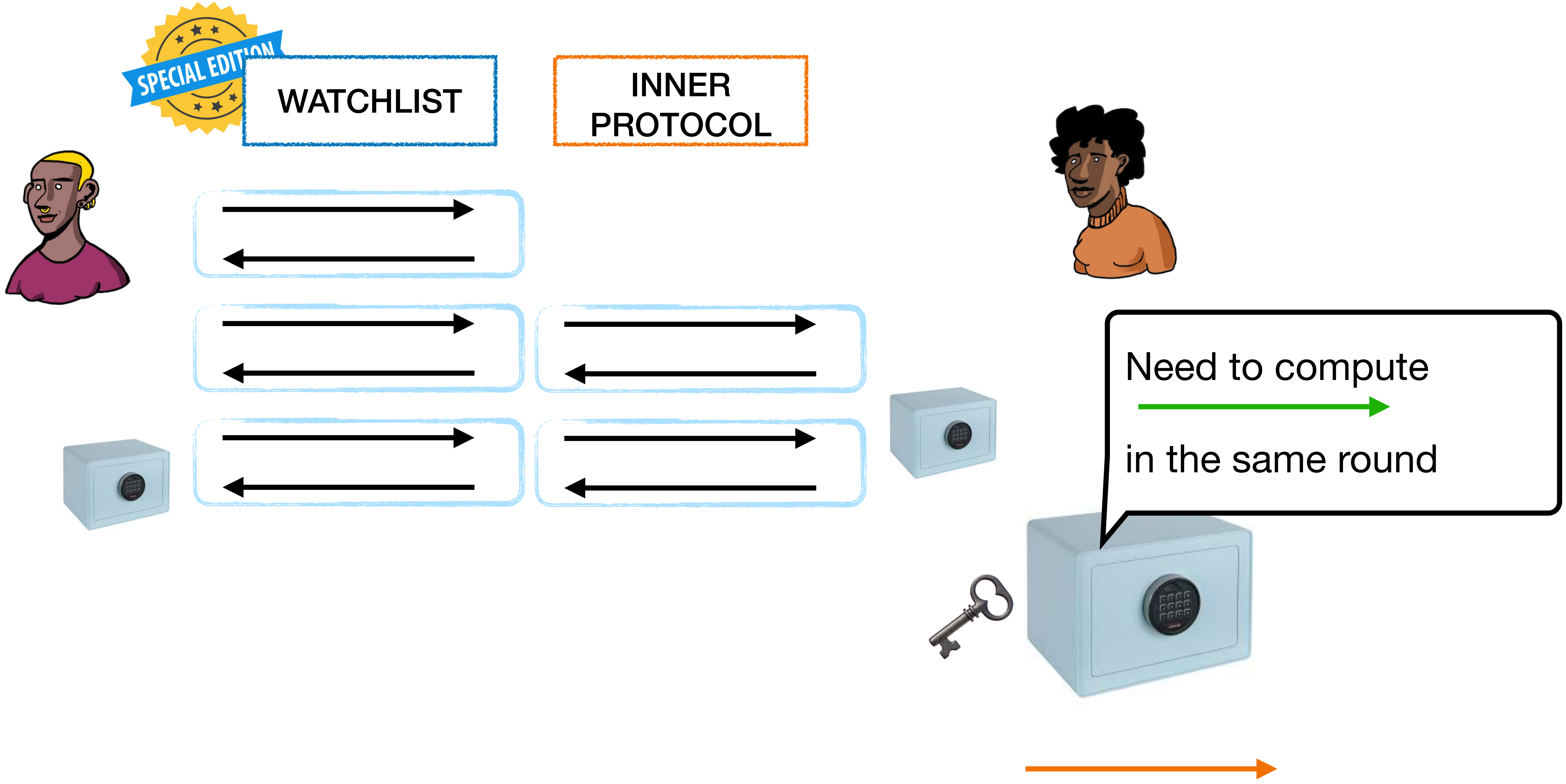
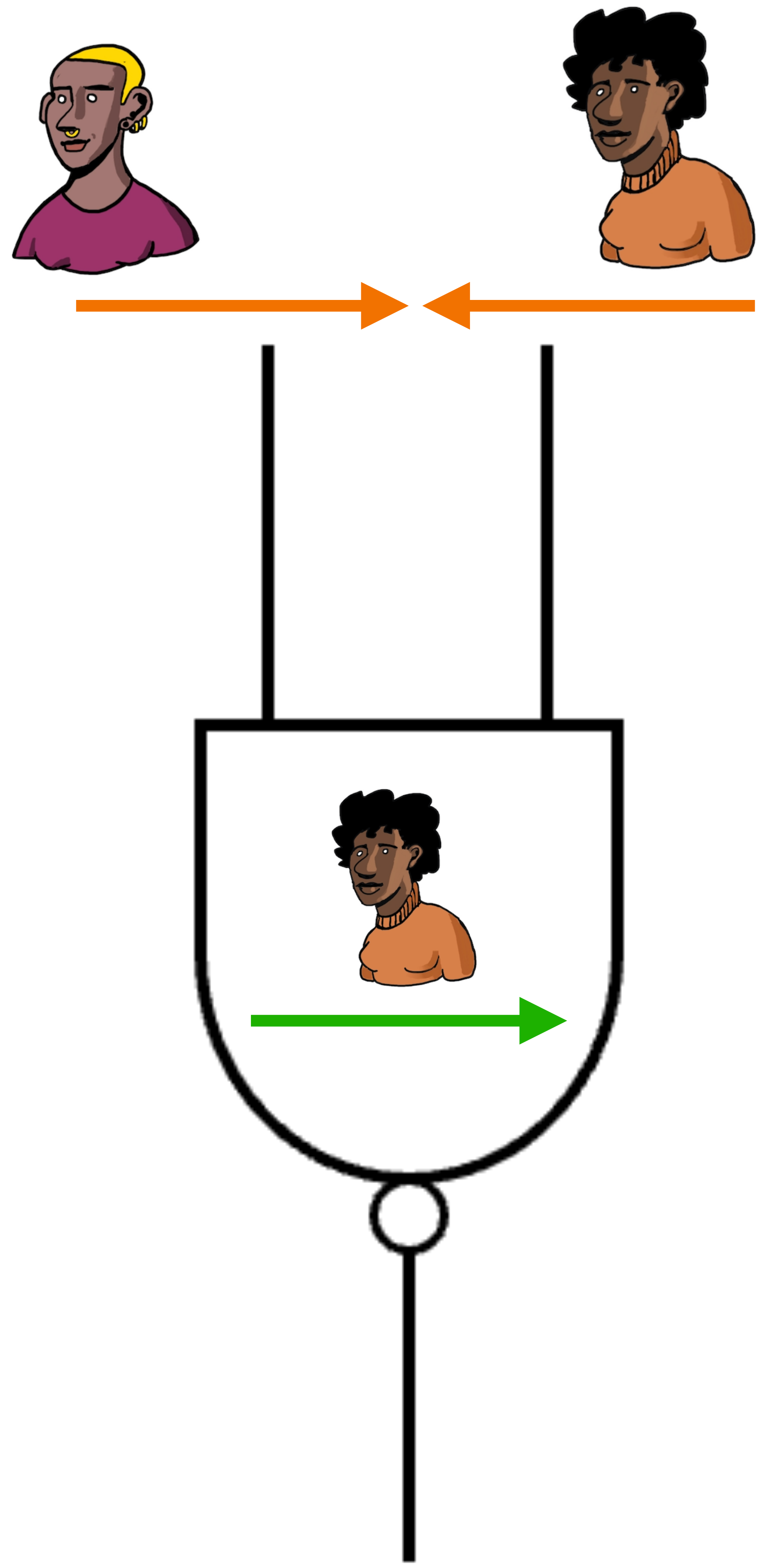


Our Approach: How to Build



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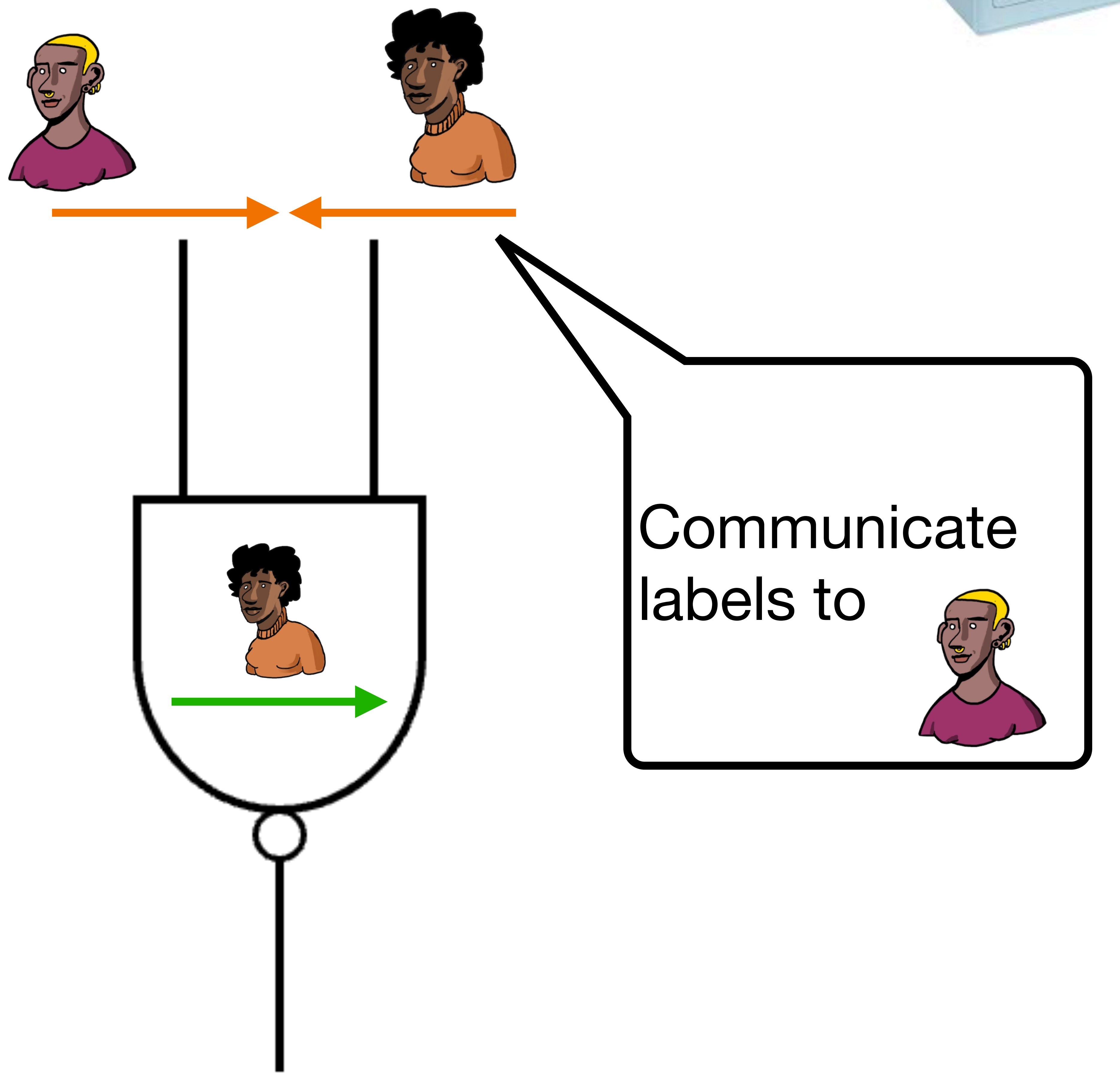
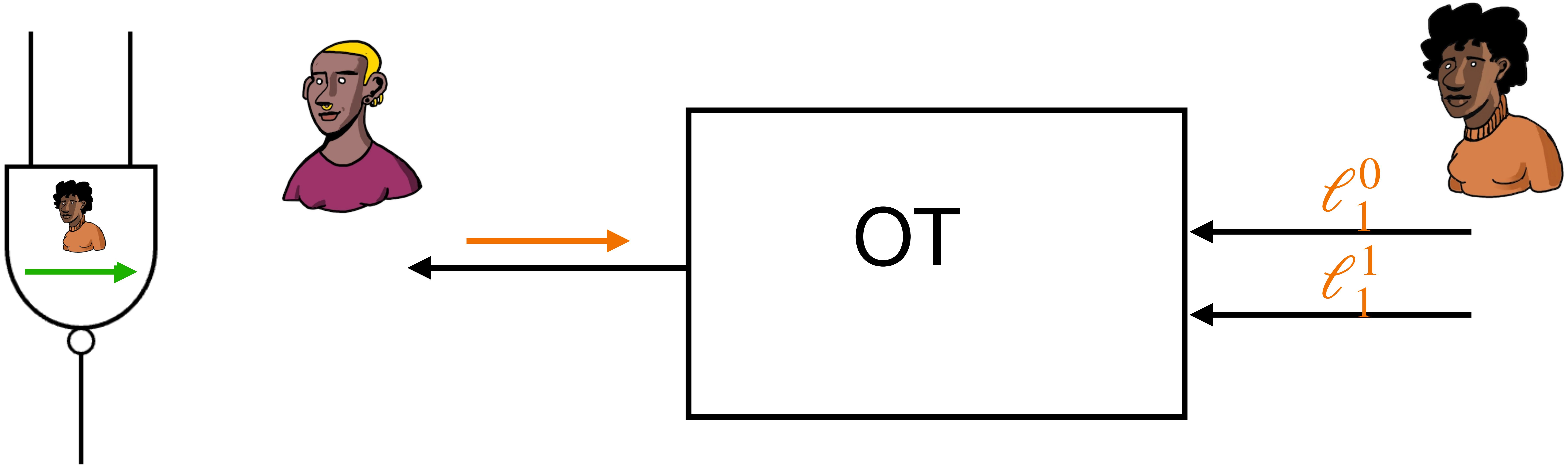
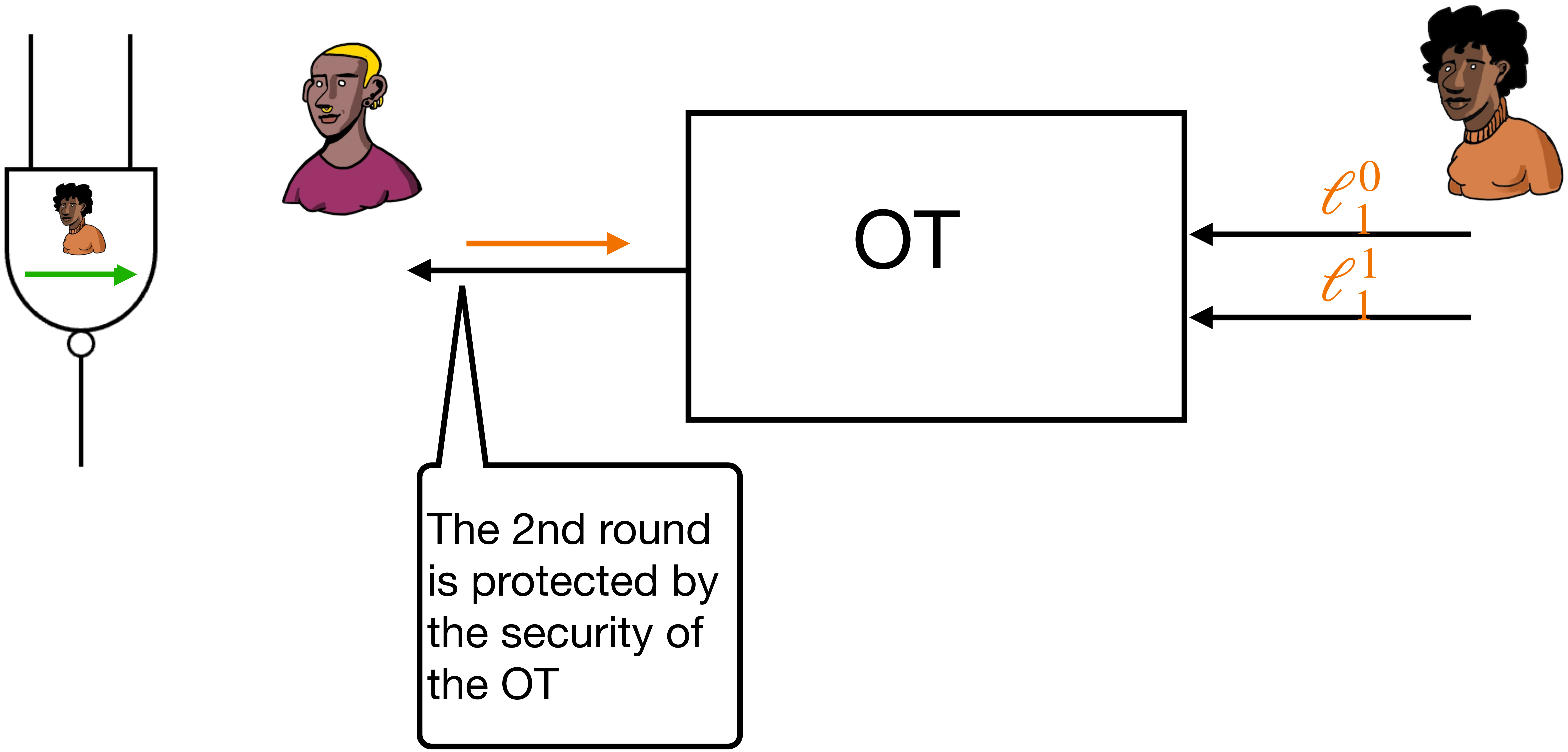


Our Approach: How to Build

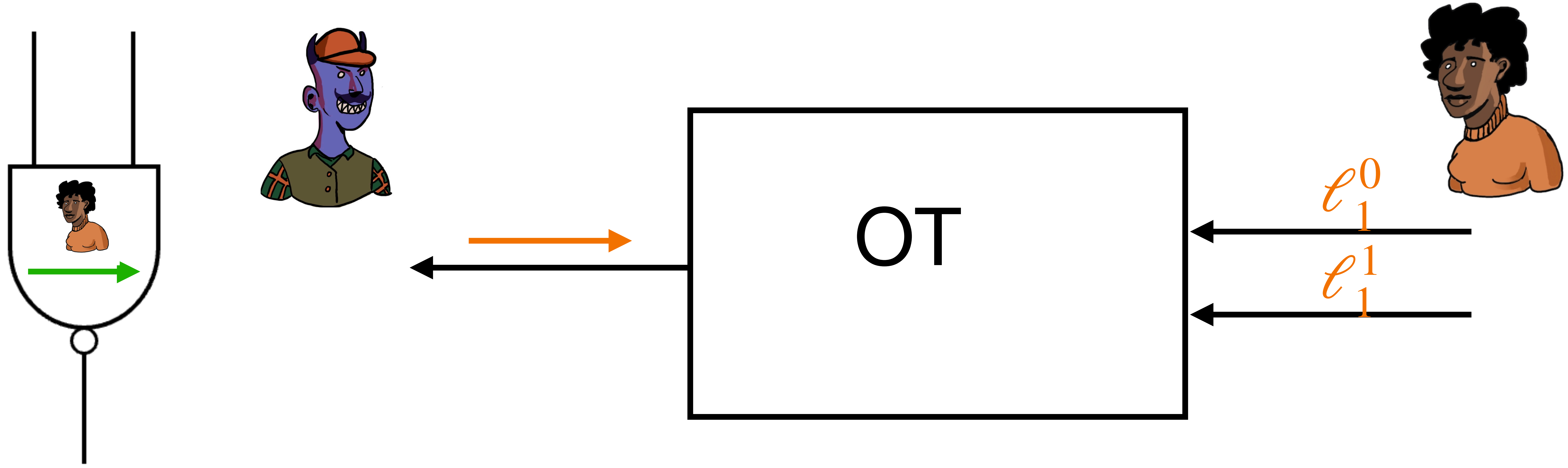


Our Approach: How to Build



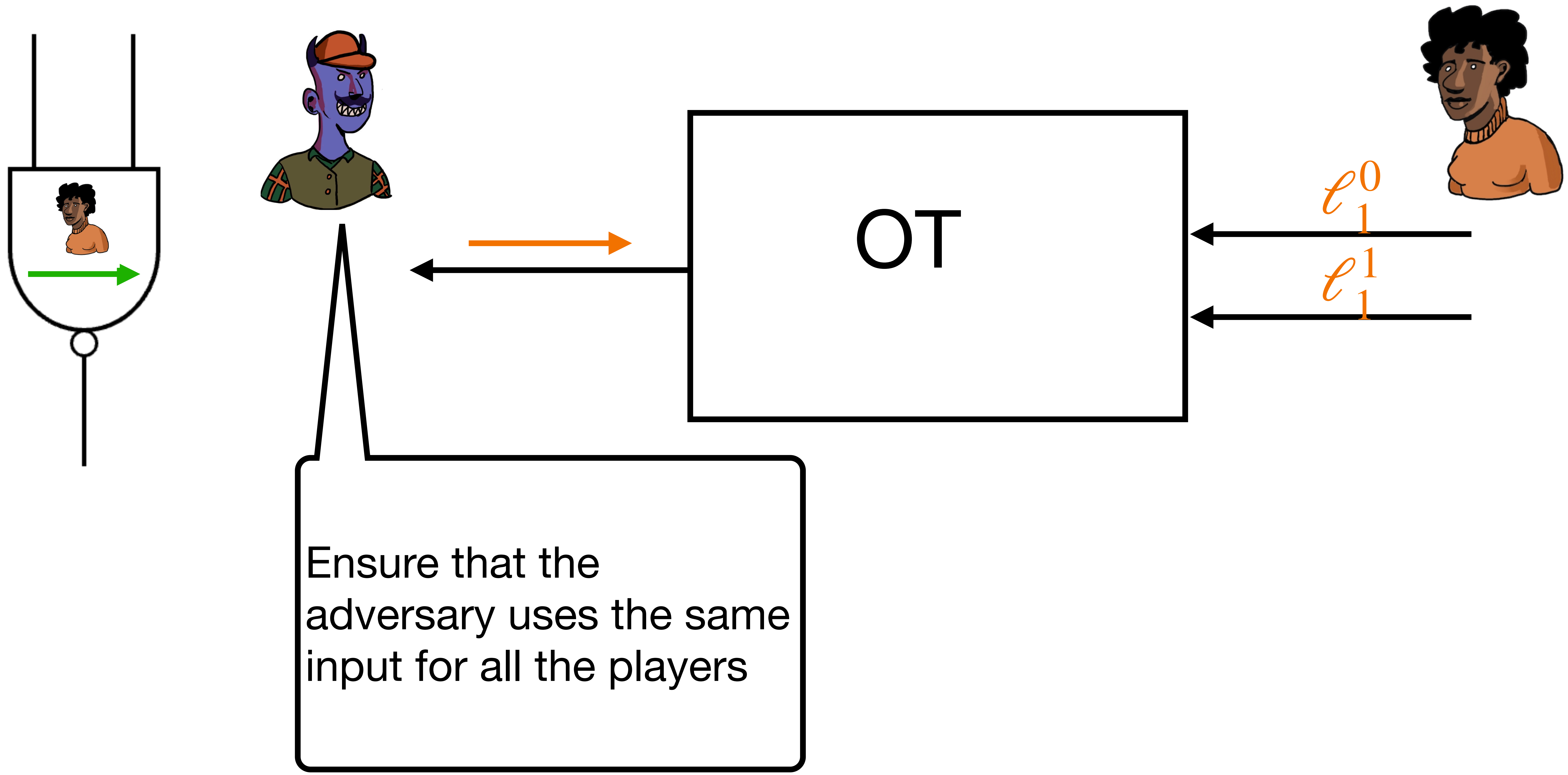
Our Approach: How to Build

Subtleties



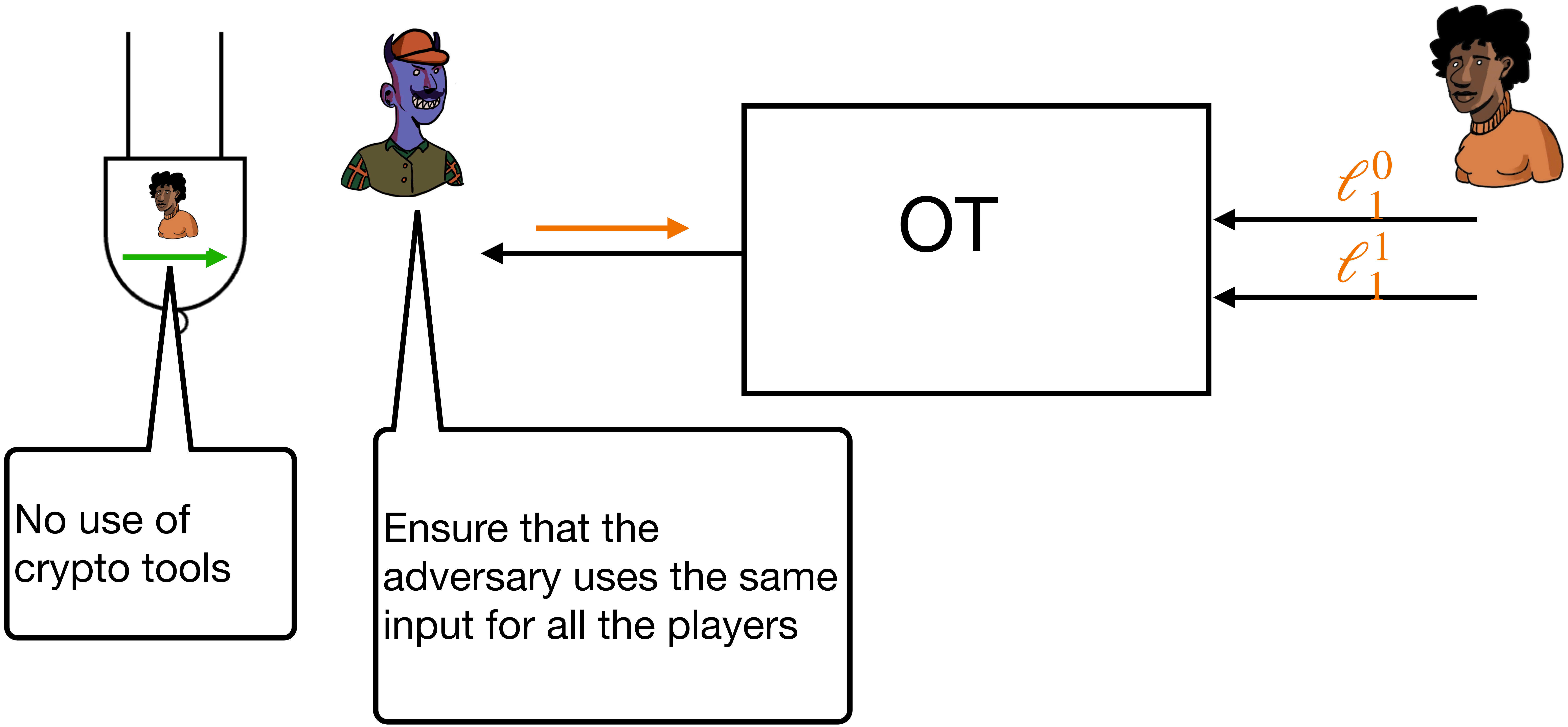
Our Approach: How to Build

Subtleties



Our Approach:
How to Build

Subtleties



Conclusion

We gave the first black-box round-optimal MPC protocol for any functionality assuming polynomial-time assumptions

Open questions

- Black box use of semi-honest OT? OR 4-round malicious OT
- What about identifiable abort?

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THANKS!