FastPay

High-Performance Byzantine Fault Tolerant Settlement

FastPay

Acknowledgments

Mathieu Baudet

George Danezis

Alberto Sonnino

Facebook Novi

What is FastPay?

A distributed (BFT) system

A standalone system

- An RTGS setting cross-bank payments

A side infrastructure

- Side chain to reduce latency of payments

What is FastPay?

A distributed (BFT) system

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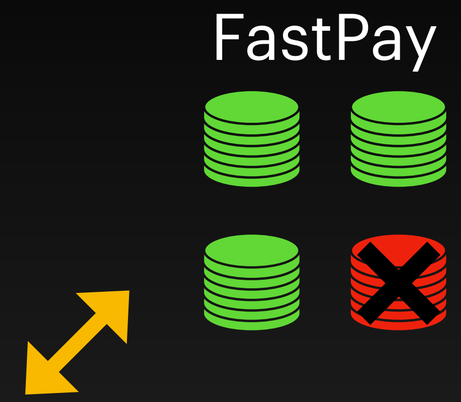
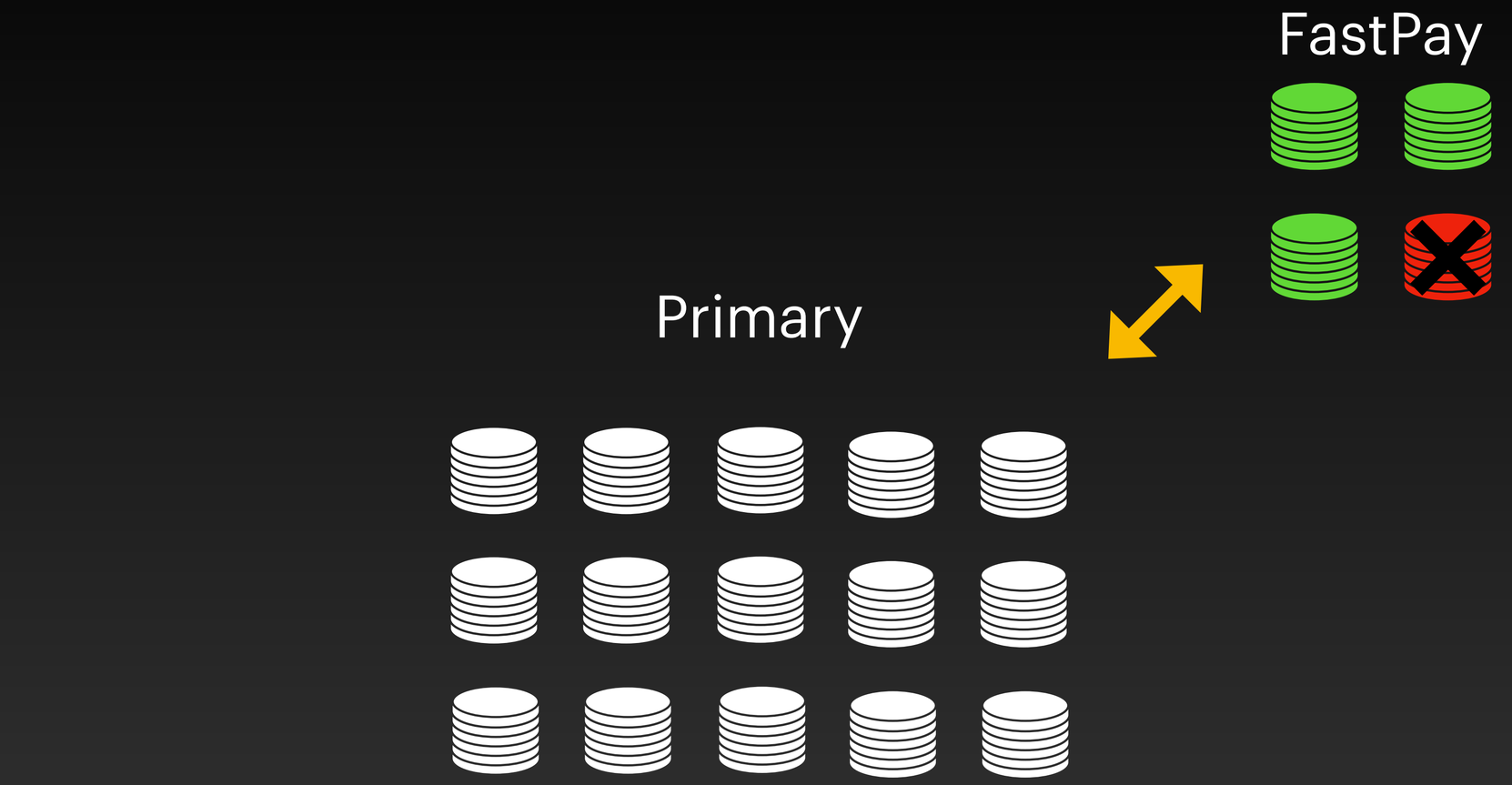
Overview



Primary

Overview



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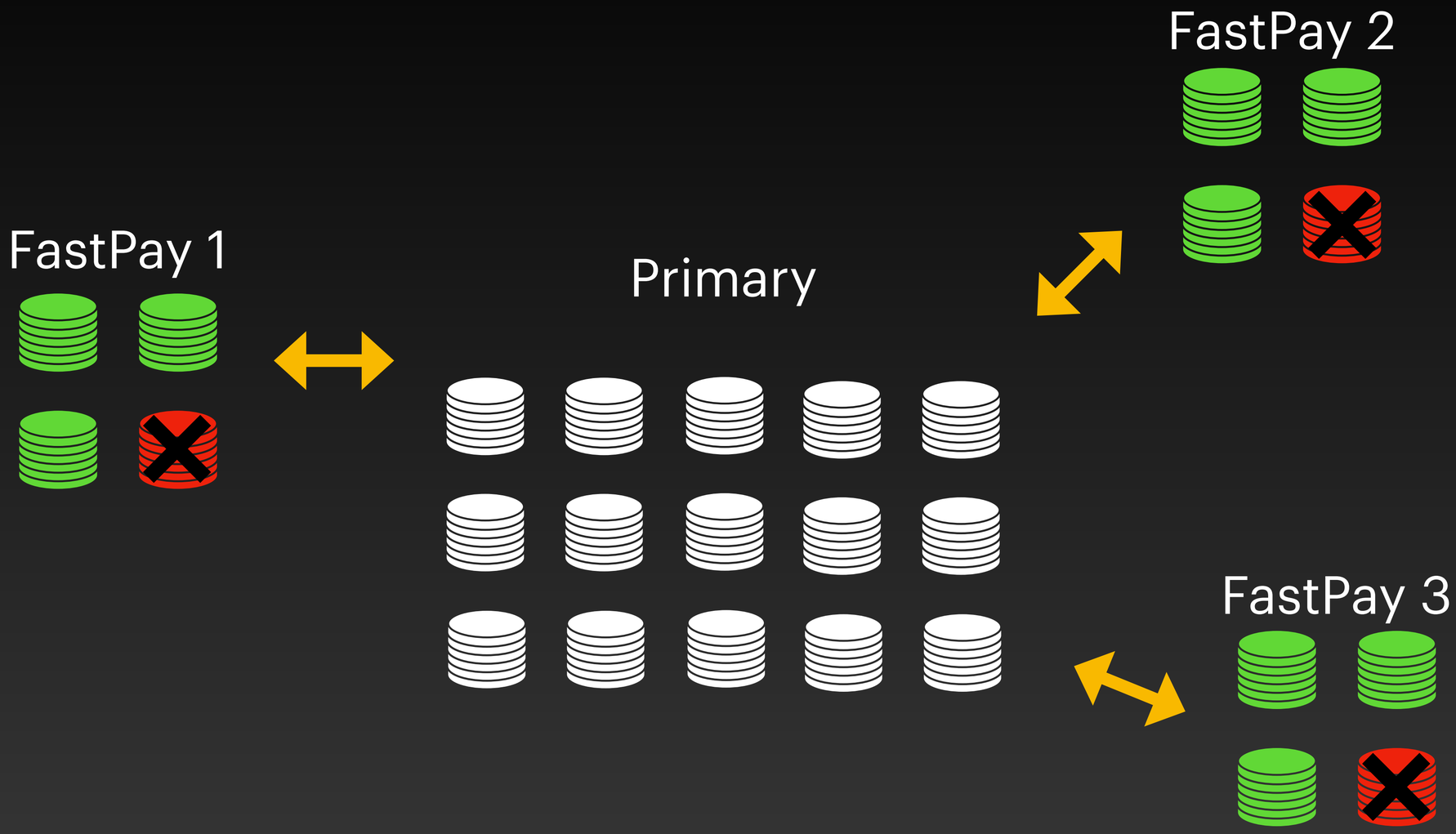


Make it practical for retail payment at physical points of sale

This requires extremely low latency

What do we need?

Properties

What we want

- Low latency
- BFT reliance
- Fast finality
- Hight capacity

Current industry

?

Centralized systems

Slow Finality

In summary

What we want

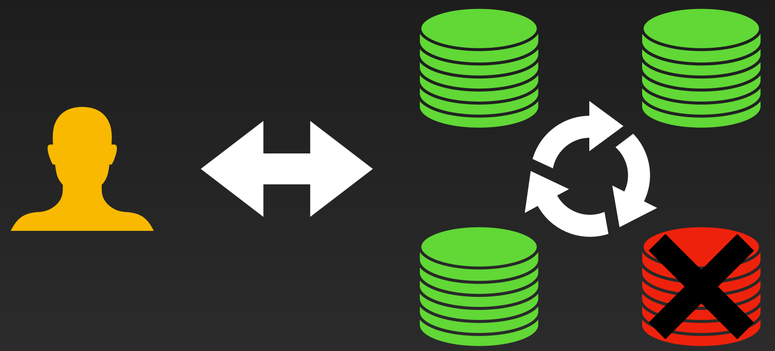
- Low latency
- BFT reliance
- Fast finality
- Hight capacity

Current industry

- Low latency (not settled)
- Centralized
- Slow finality
- Hight capacity (not settled)

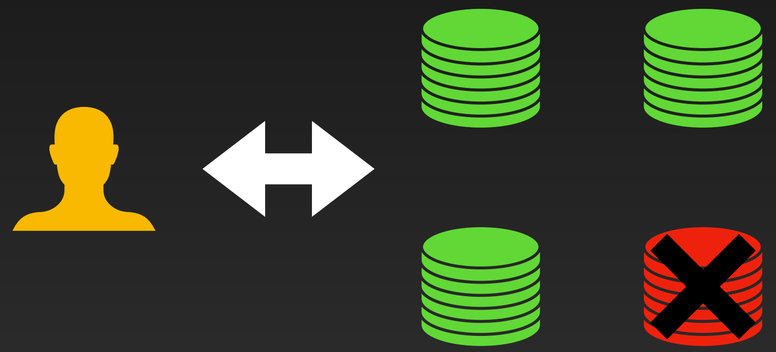
Difference with blockchains

Blockchains



Byzantine Consensus

FastPay



Byzantine Consistent Broadcast

FastPay
Authorities' state

Authorities

- Authority name and keys
- Committee information
- Accounts information
- Last primary tx index

Each account

- Verification key
- Balance
- Sequence number
- Last transfer order
- List of certificates and synchronization orders

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Clients' state

- Their account's address
- Their secret key
- Committee information
- Last sequence number
- Last signed transfer order

FastPay

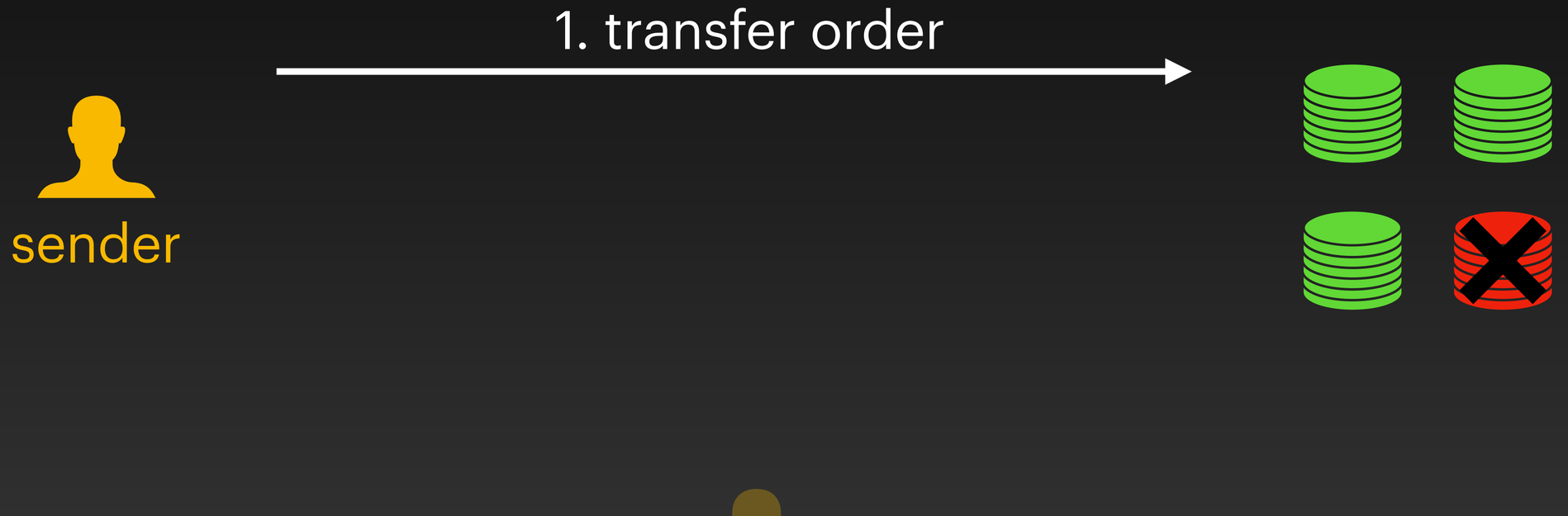
How does it work?

sender

recipient

FastPay

How does it work?



FastPay

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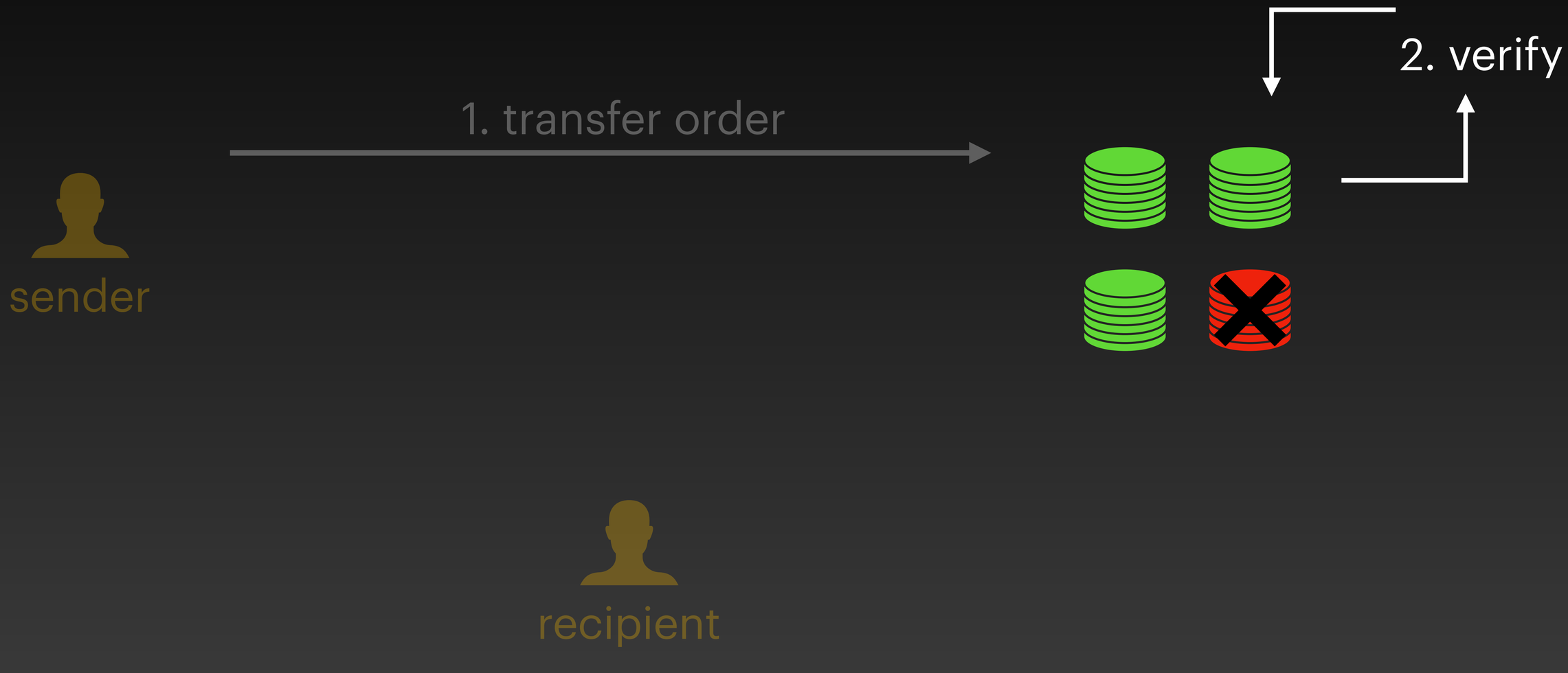

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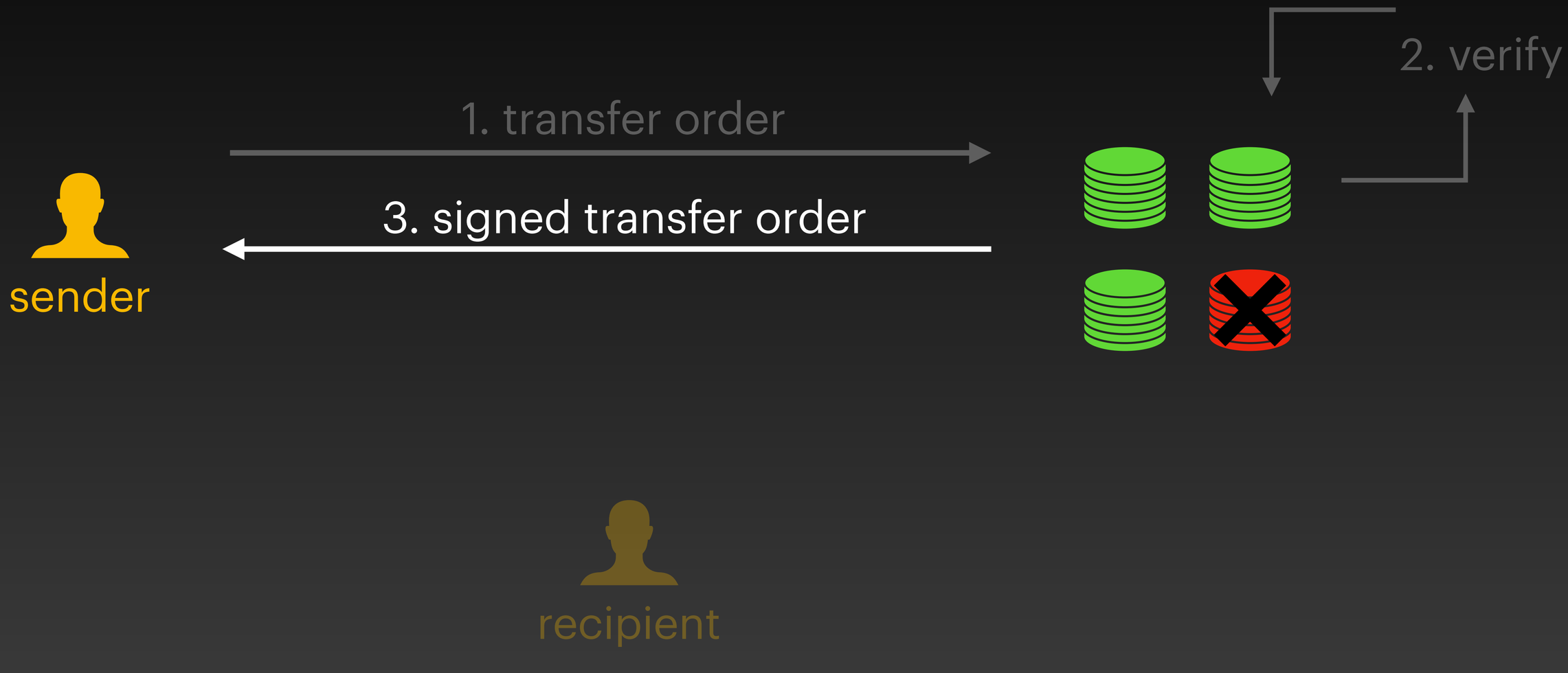

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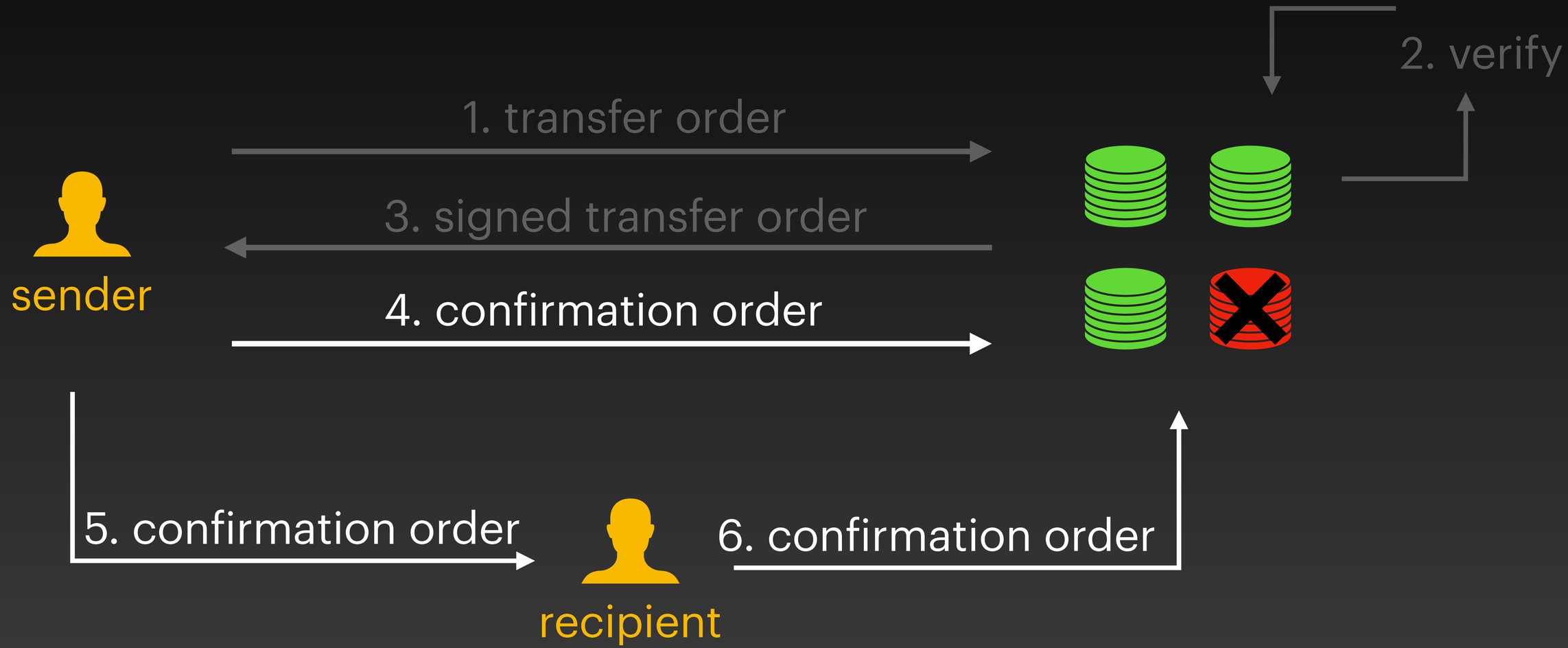

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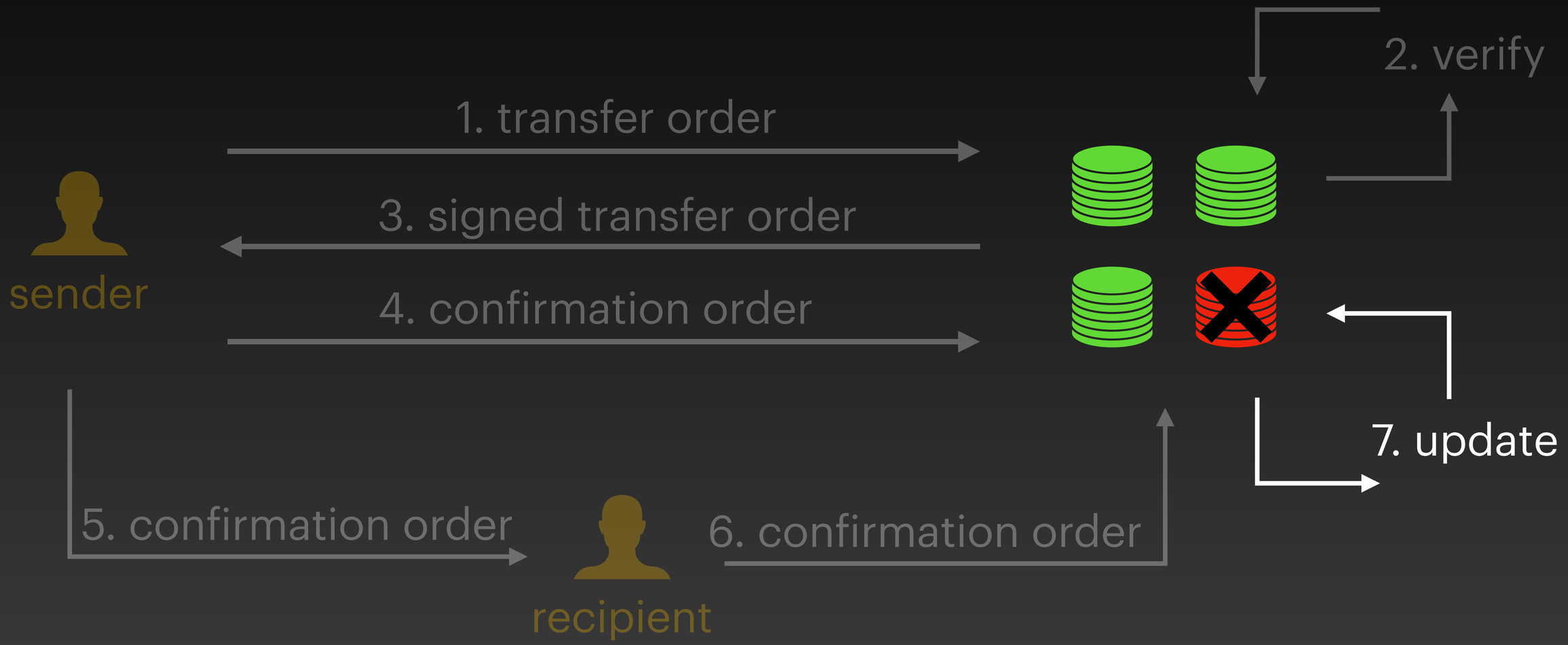
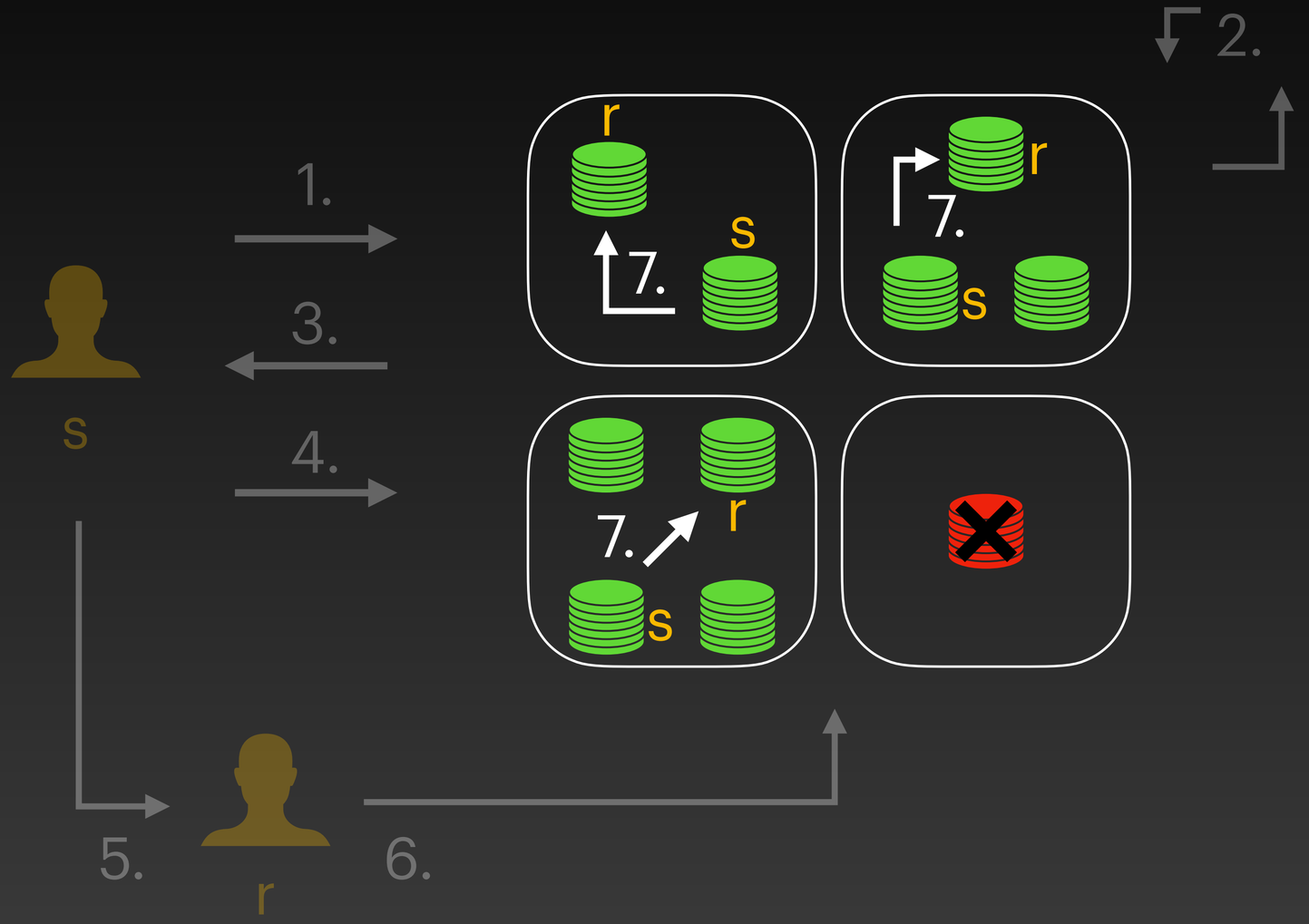


FastPay

Increasing capacity



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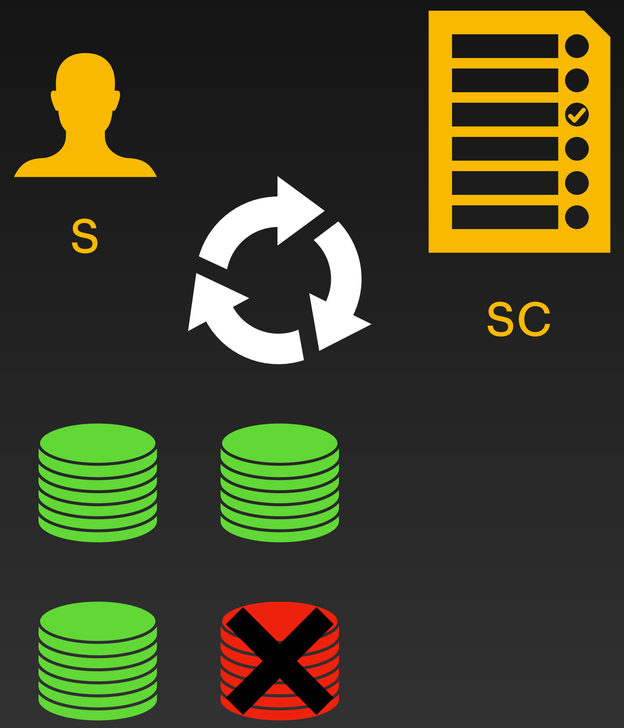
Interface it with a primary infrastructure



Smart Contract's state

- The committee information
- Total funds in the contract
- Last primary tx index
- "Redeem log"

FastPay
Authorities' state

Authorities

- Authority name and keys
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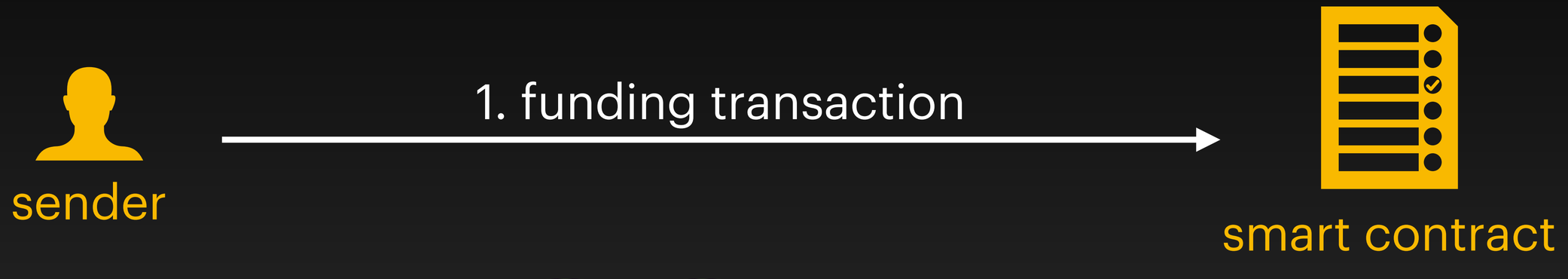
FastPay

From primary infrastructure to FastPay



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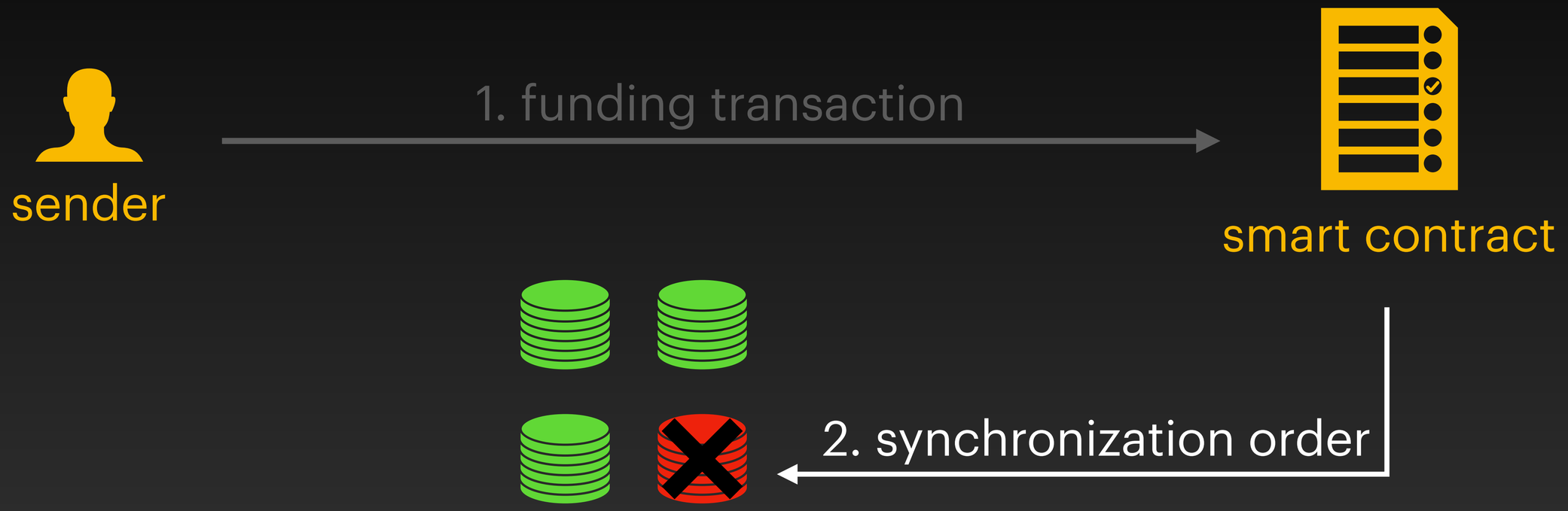

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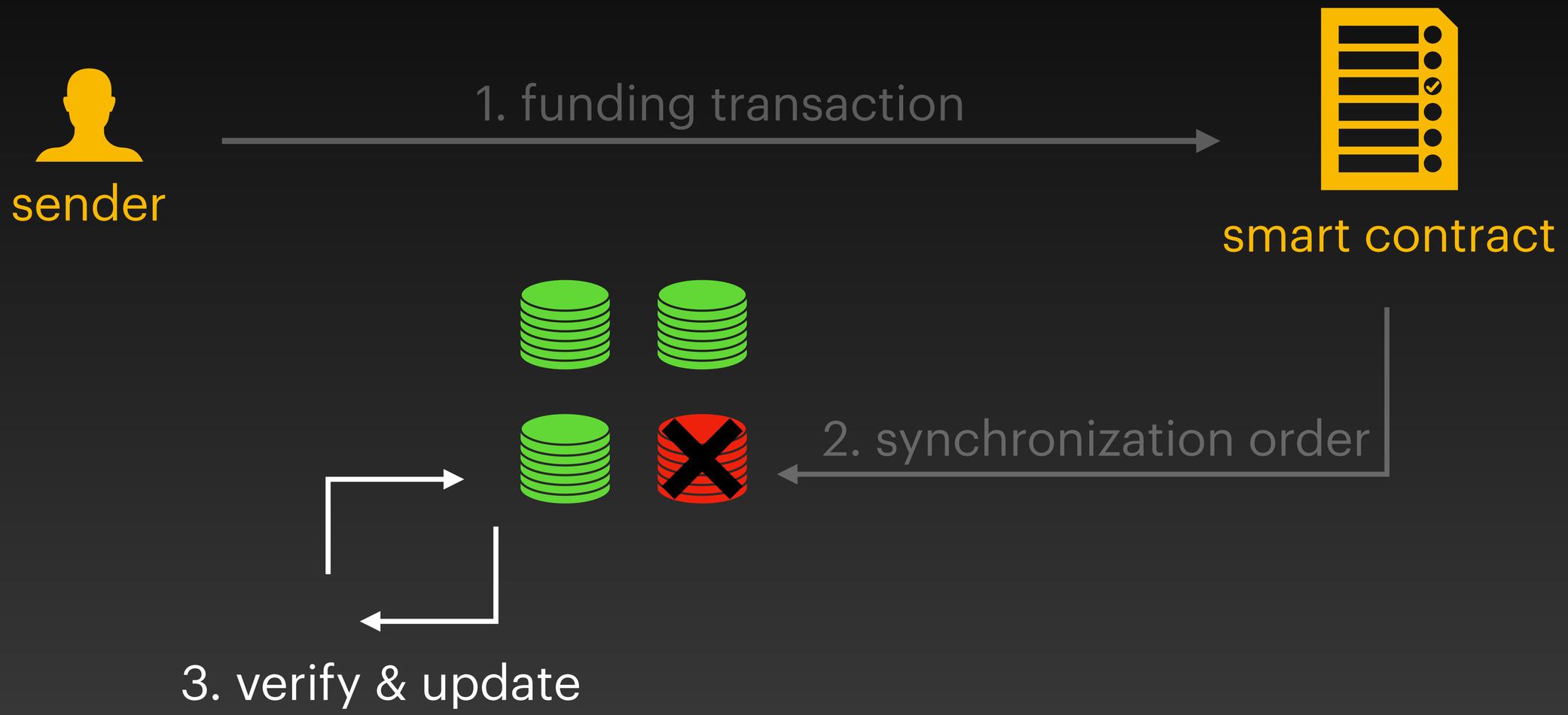

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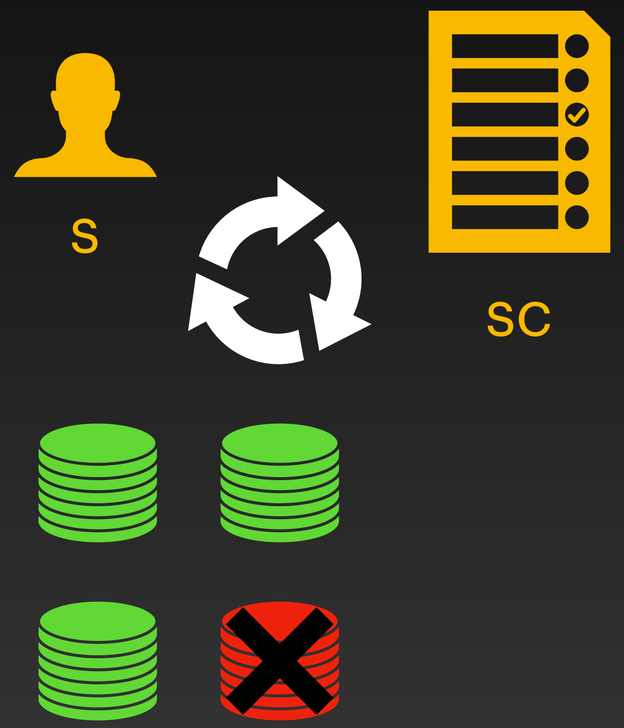

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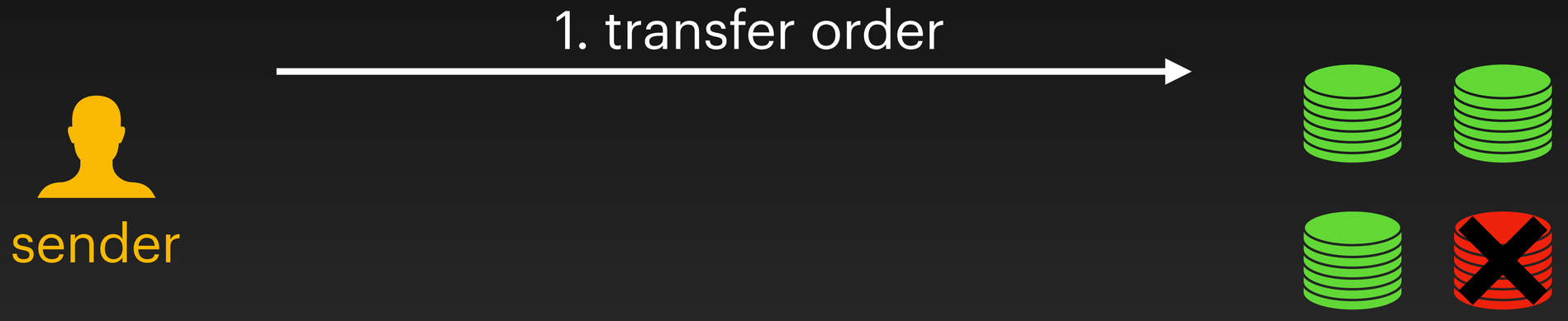
FastPay

From the primary infrastructure to FastPay



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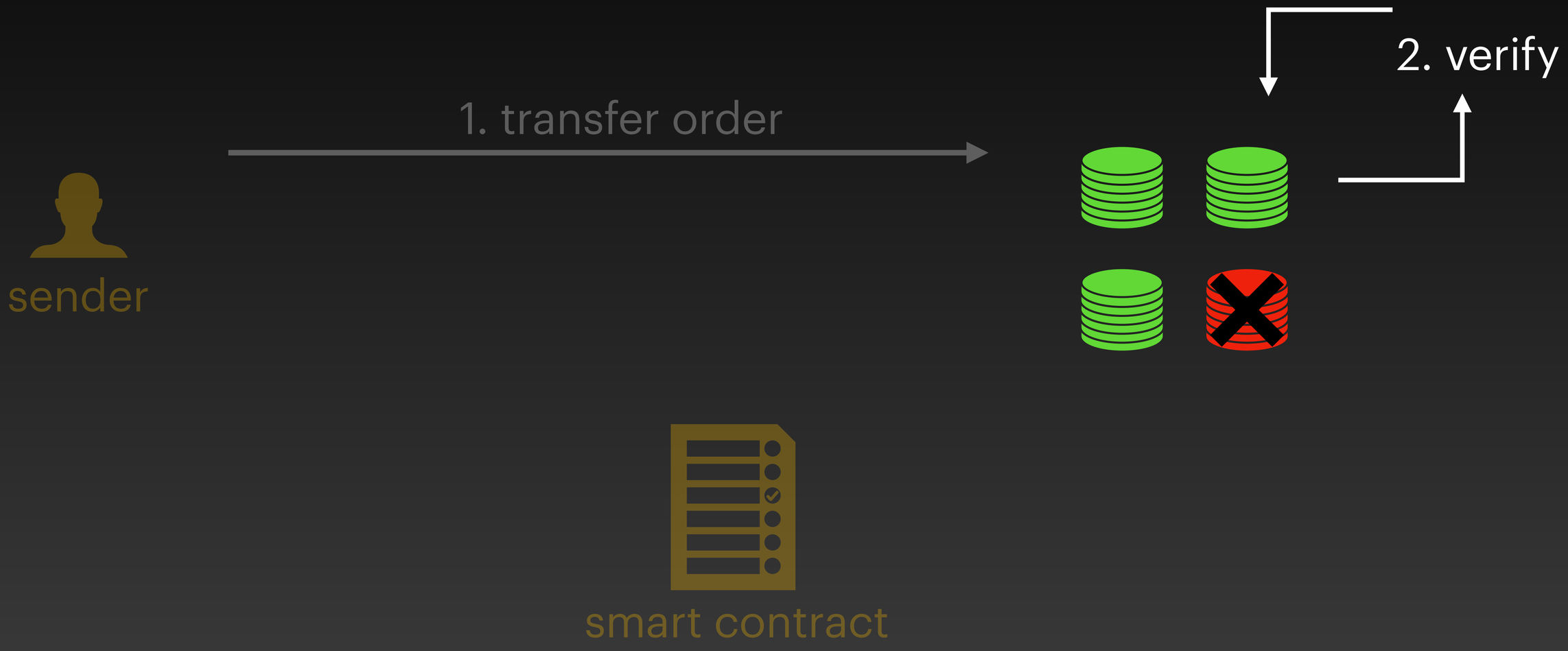

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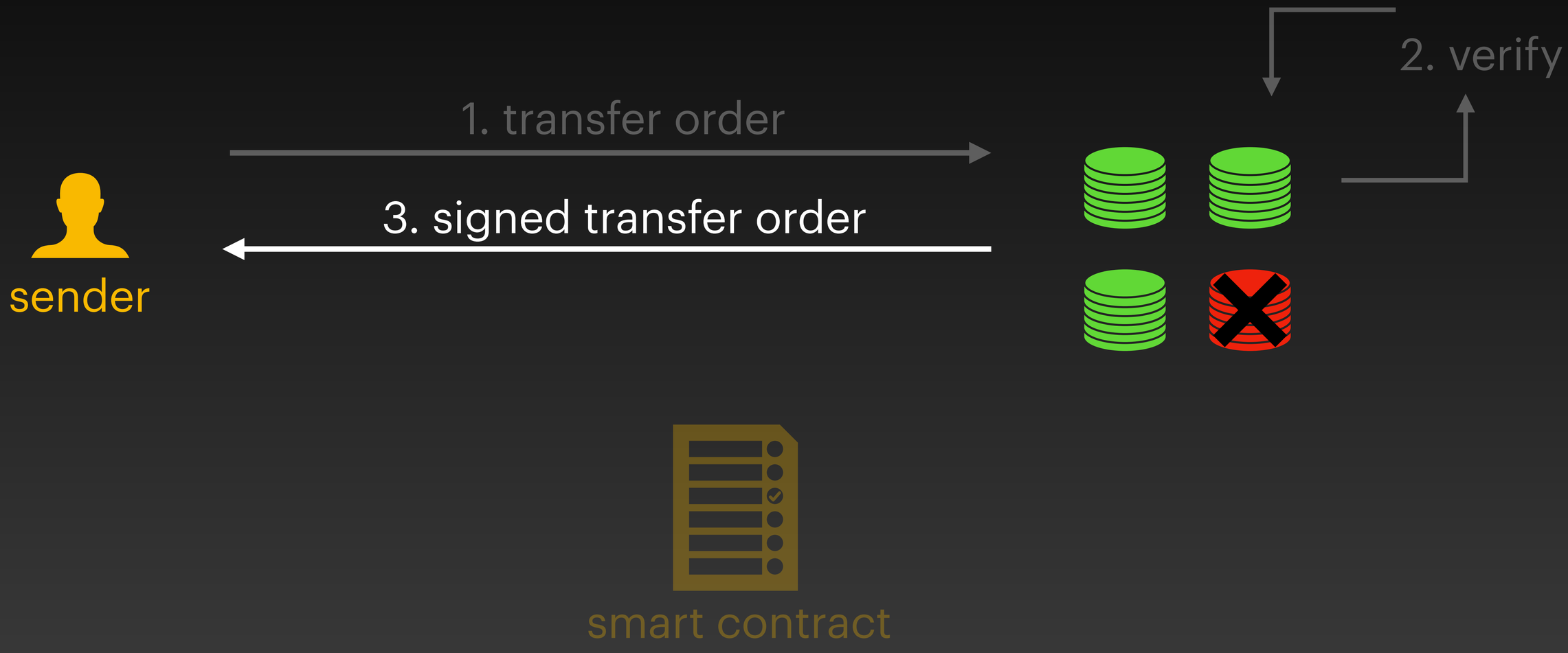

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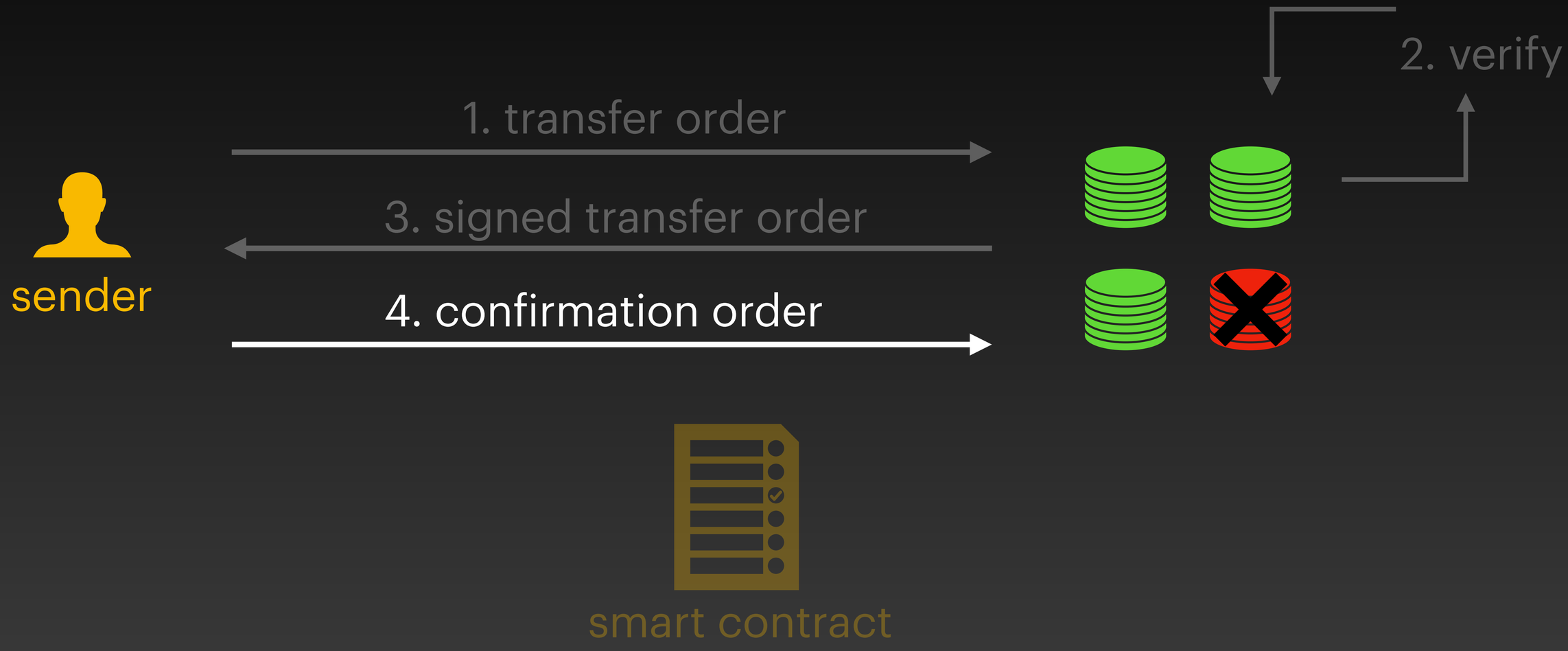

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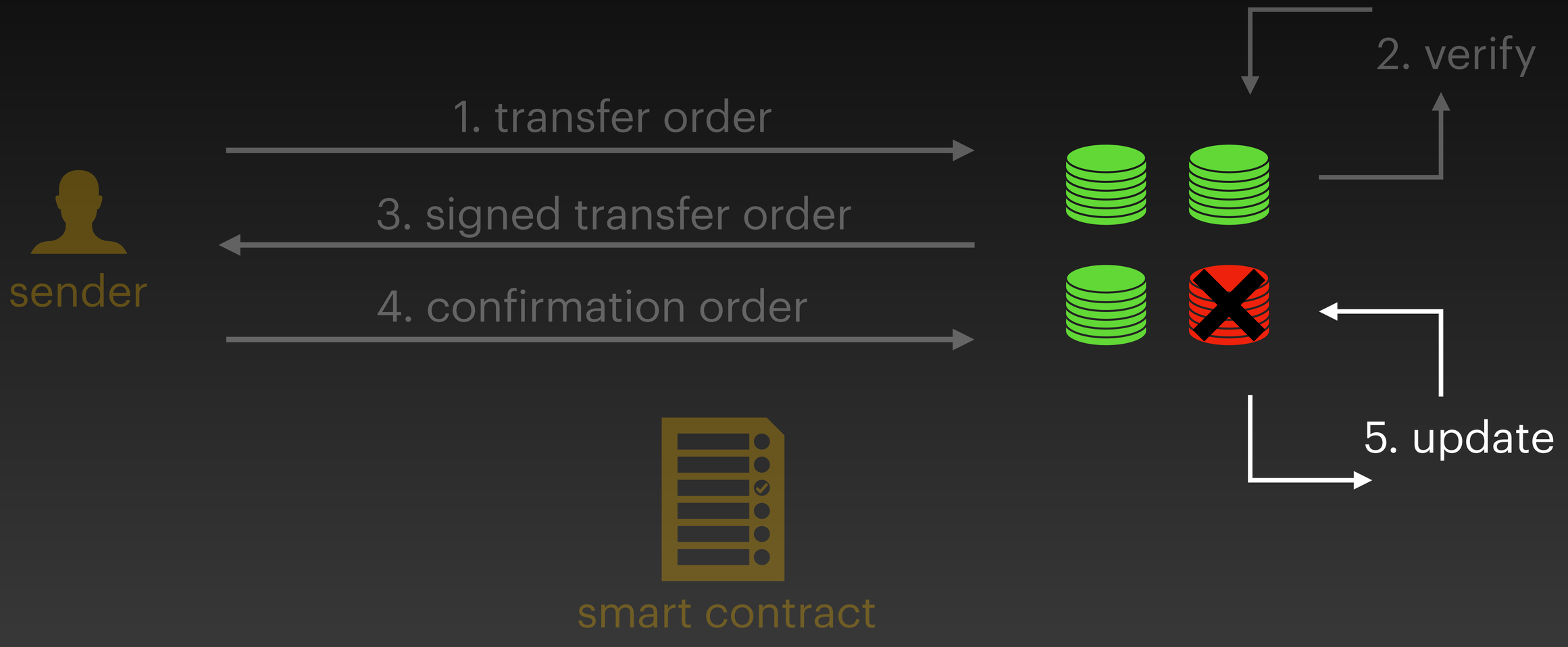

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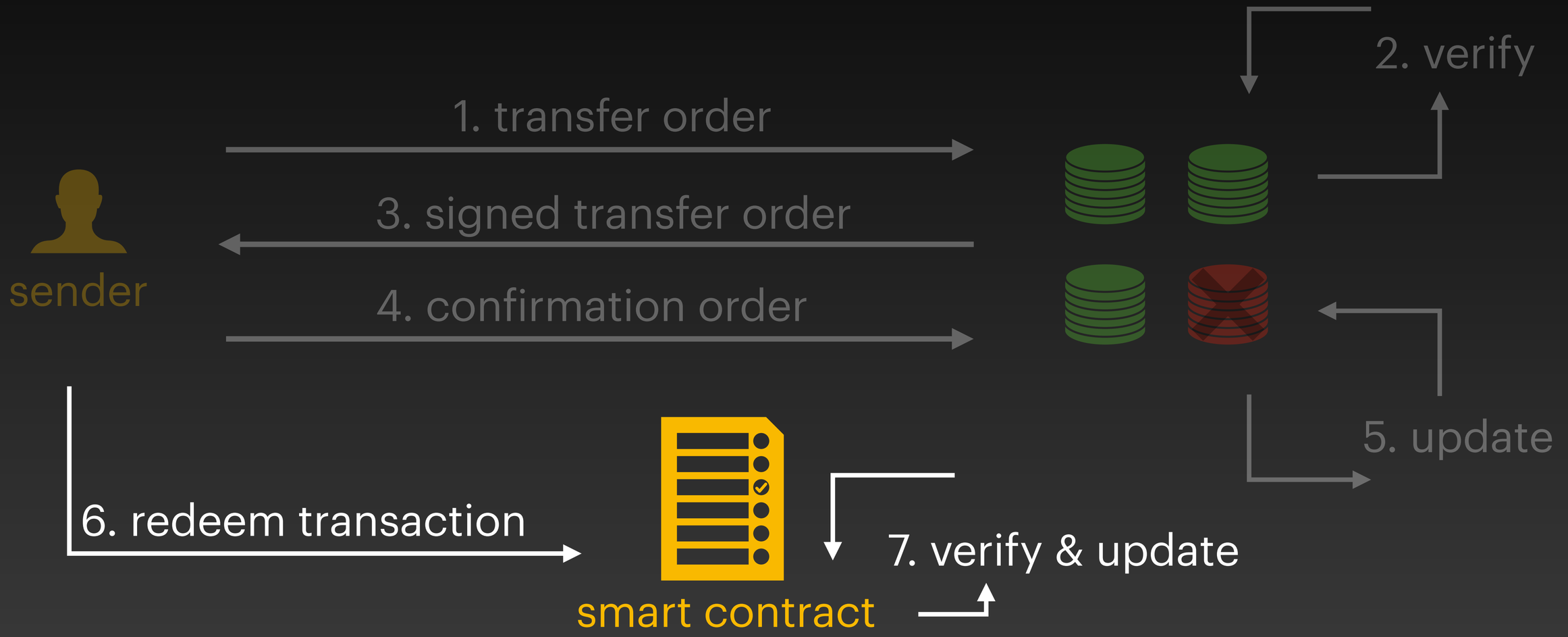


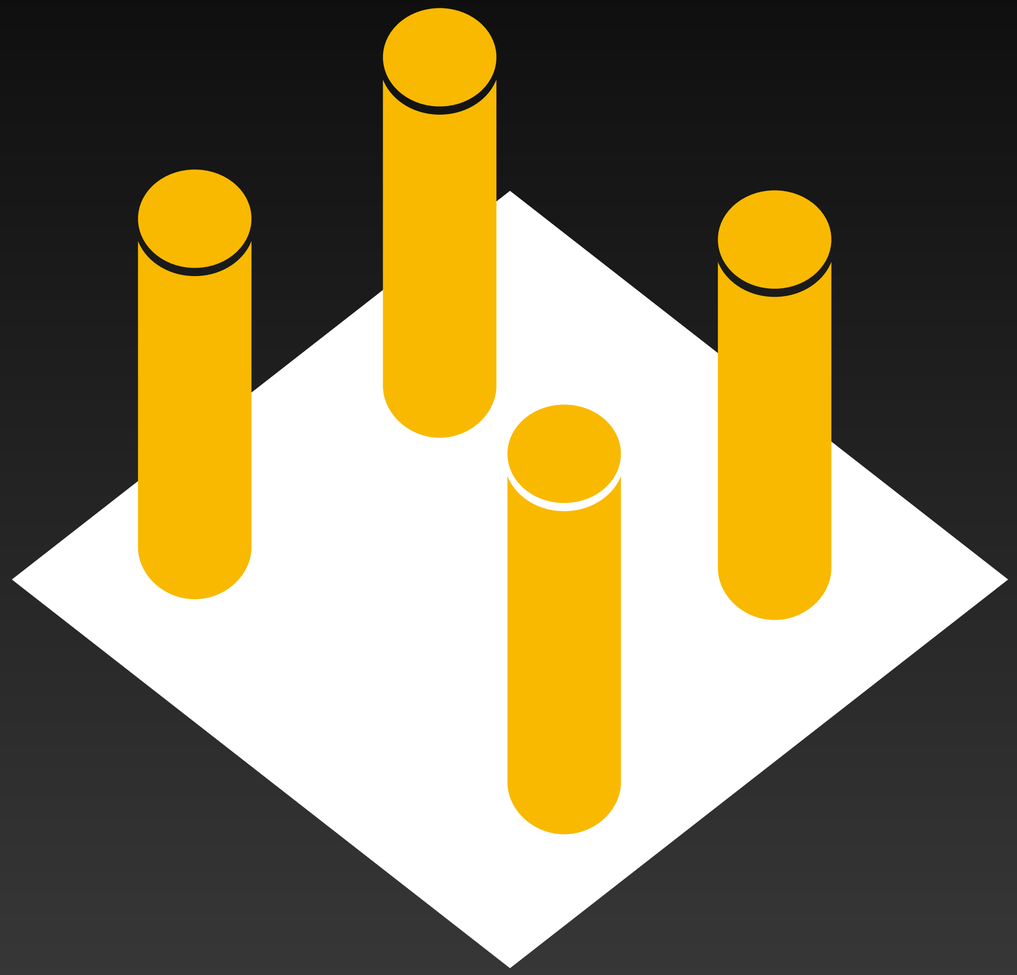
FastPay
Implementation

- Written in Rust
- Networking: Tokio & UDP
- Cryptography: ed25519-dalek

https://github.com/novifinancial/fastpay

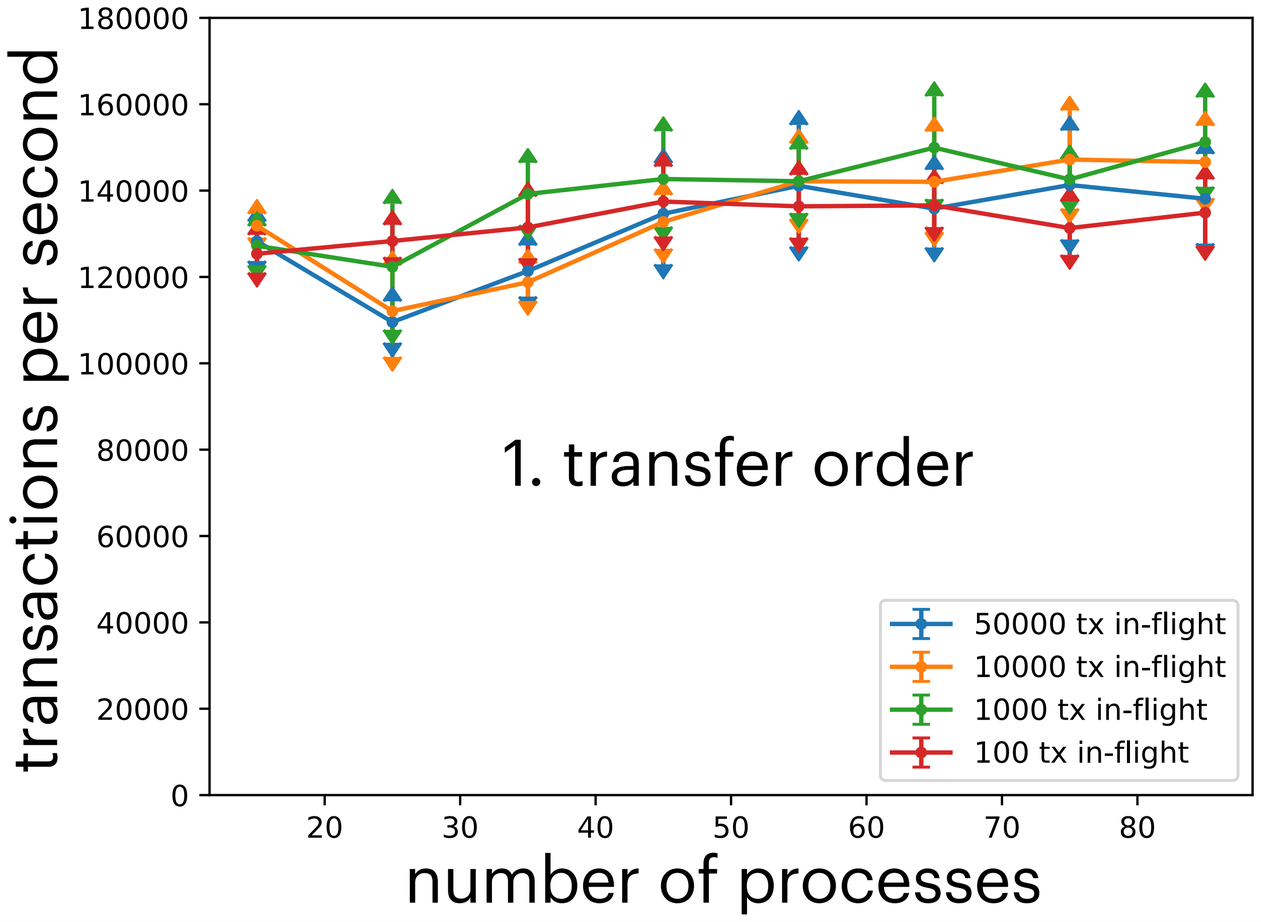
FastPay

Throughput Evaluation



FastPay

High concurrency



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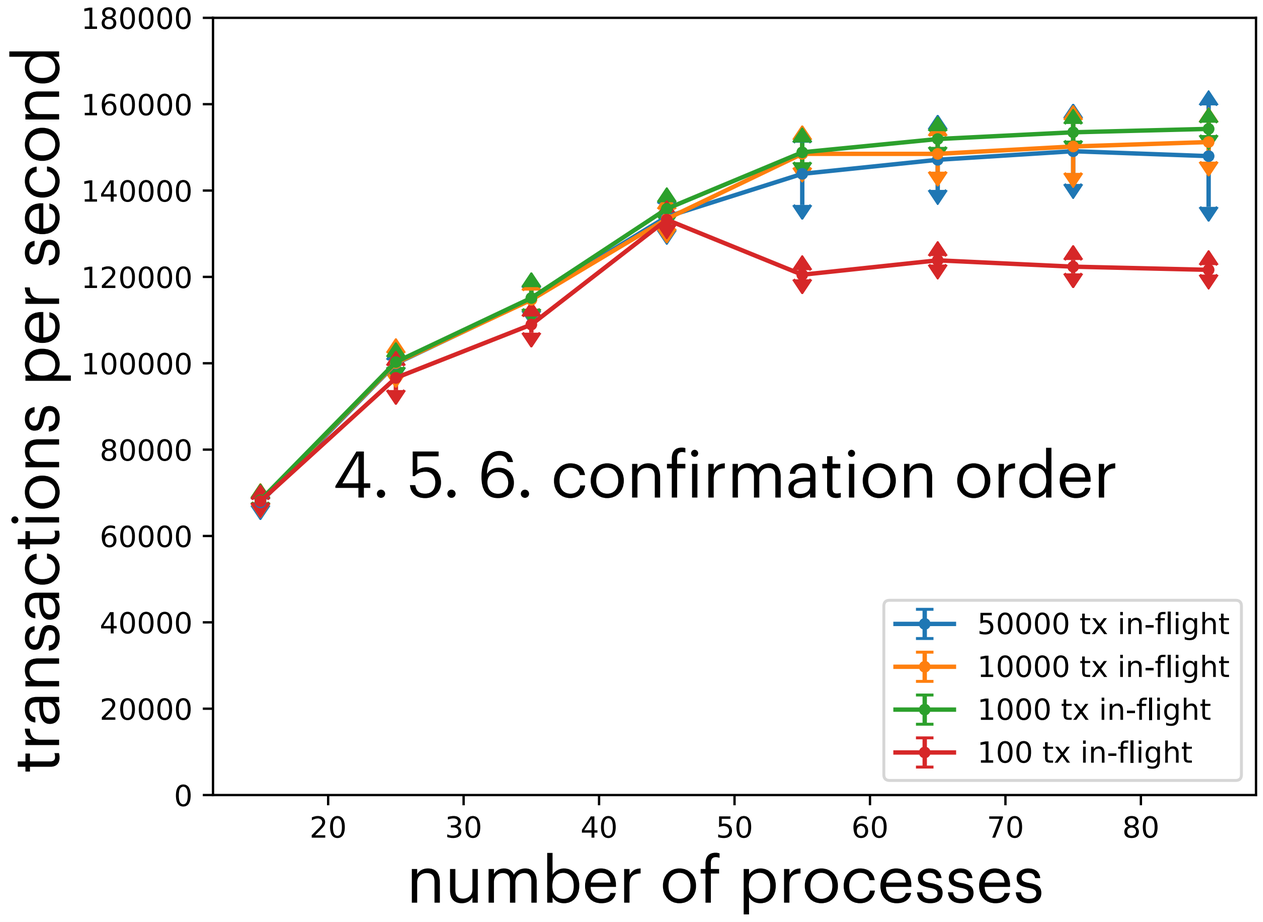
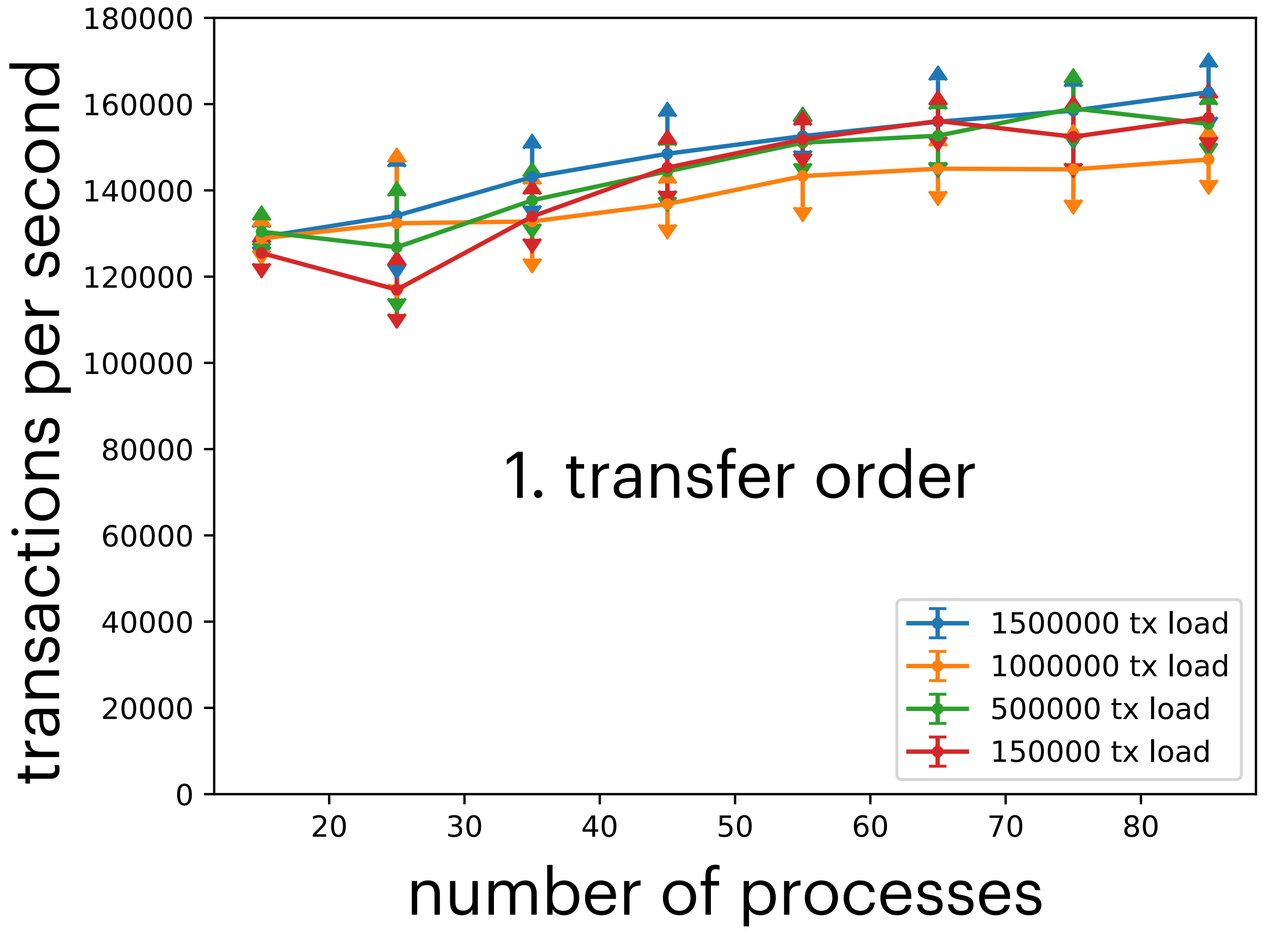


FastPay
Robustness



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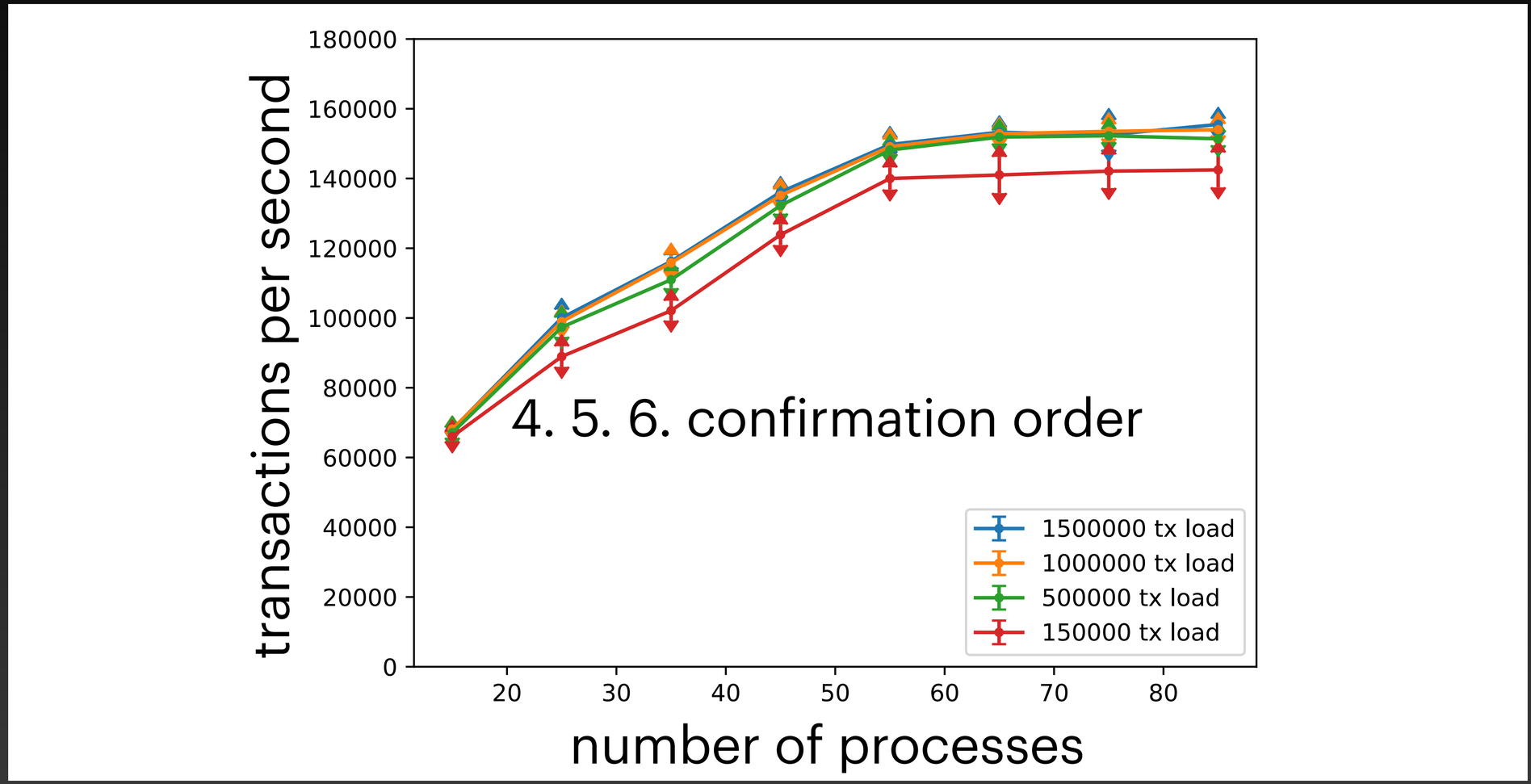
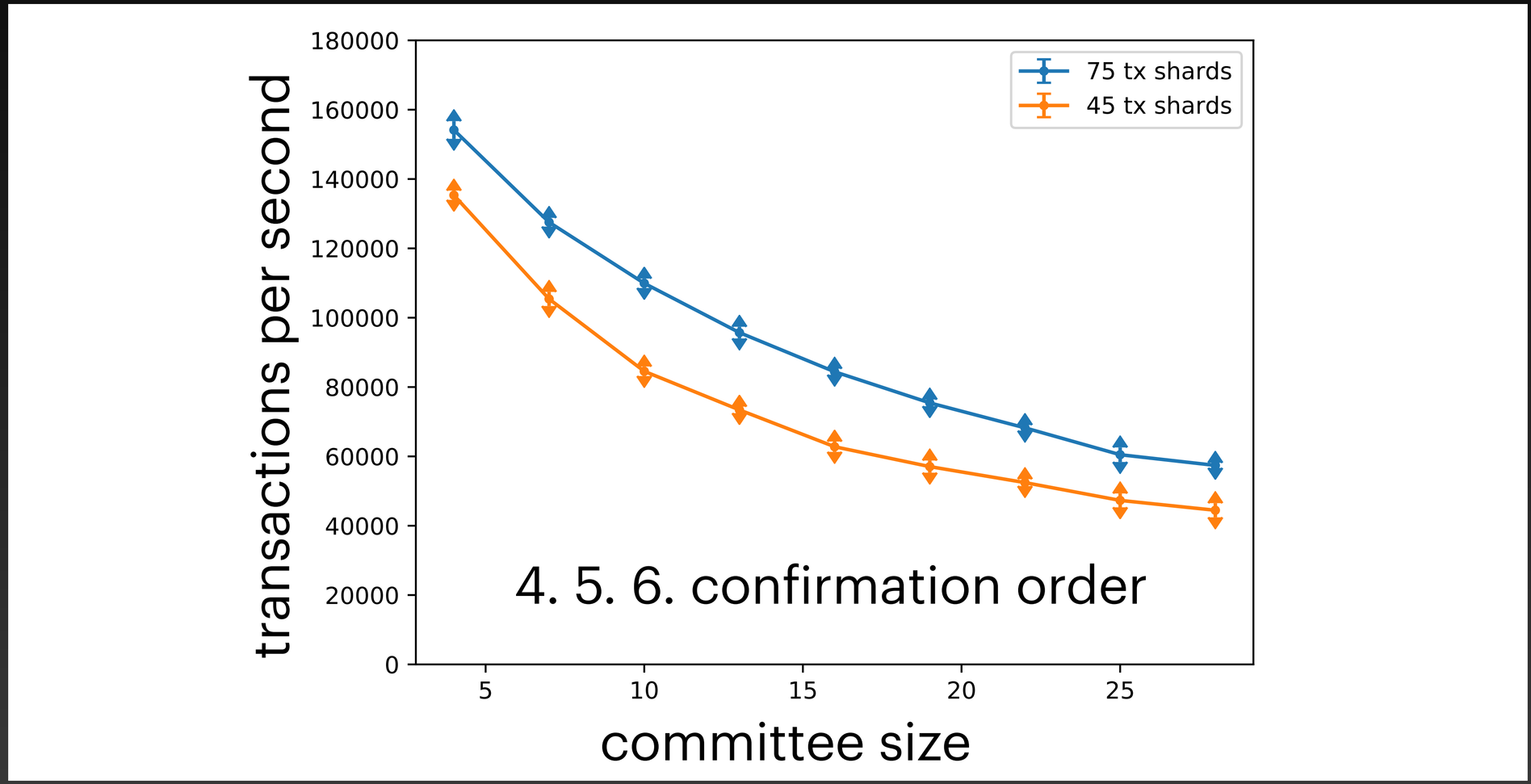


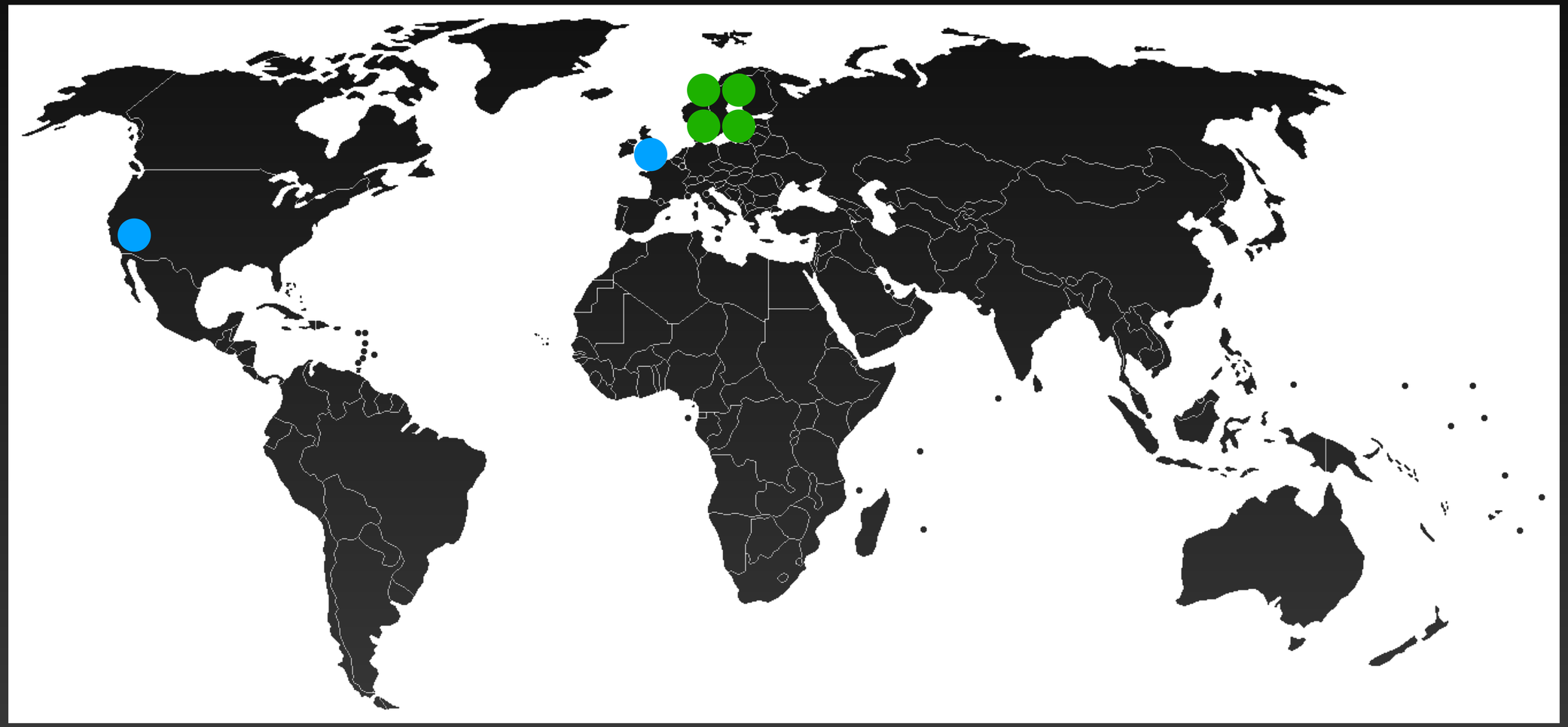
FastPay

Influence of the number of authorities

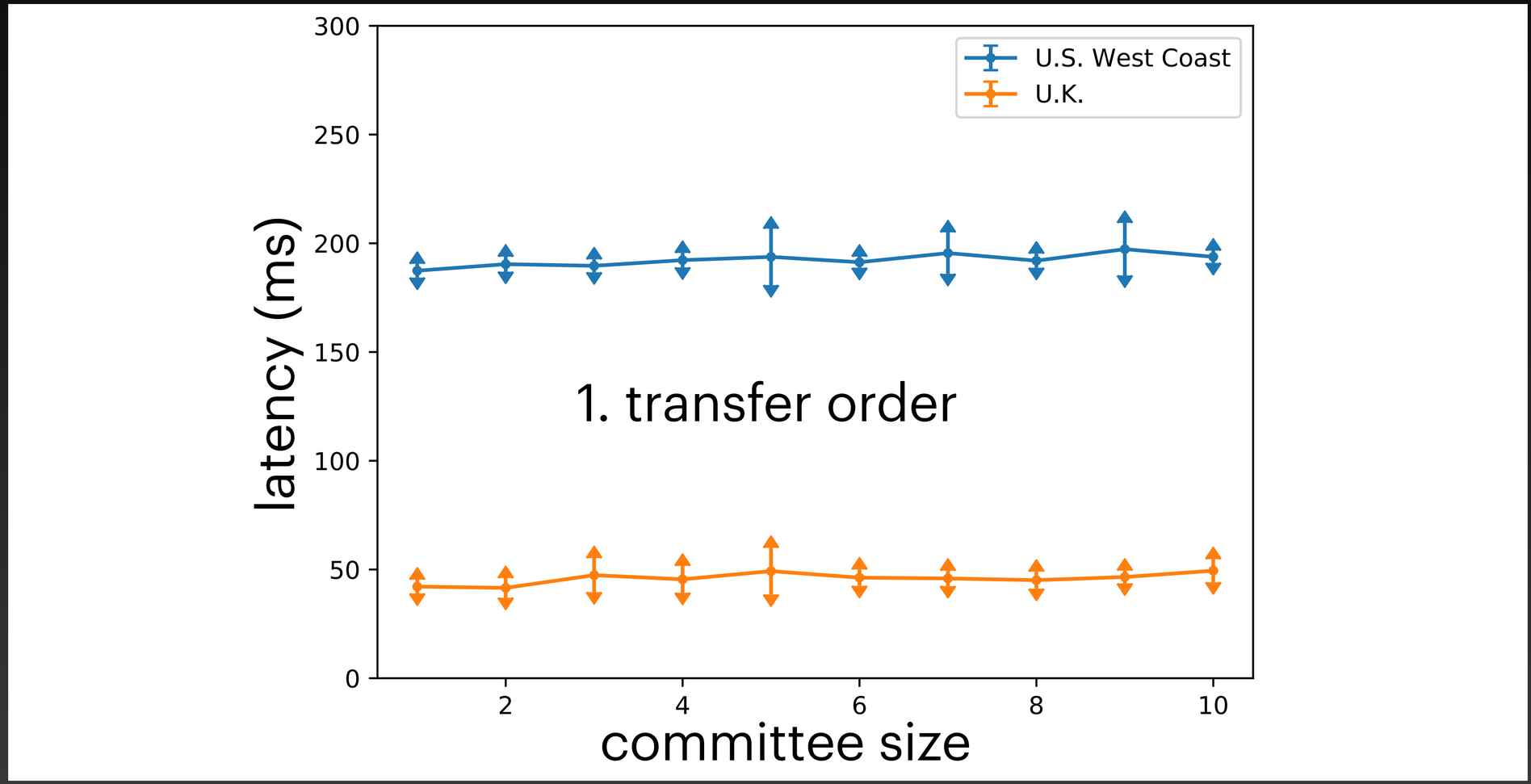


FastPay

Latency setup



FastPay
Latency



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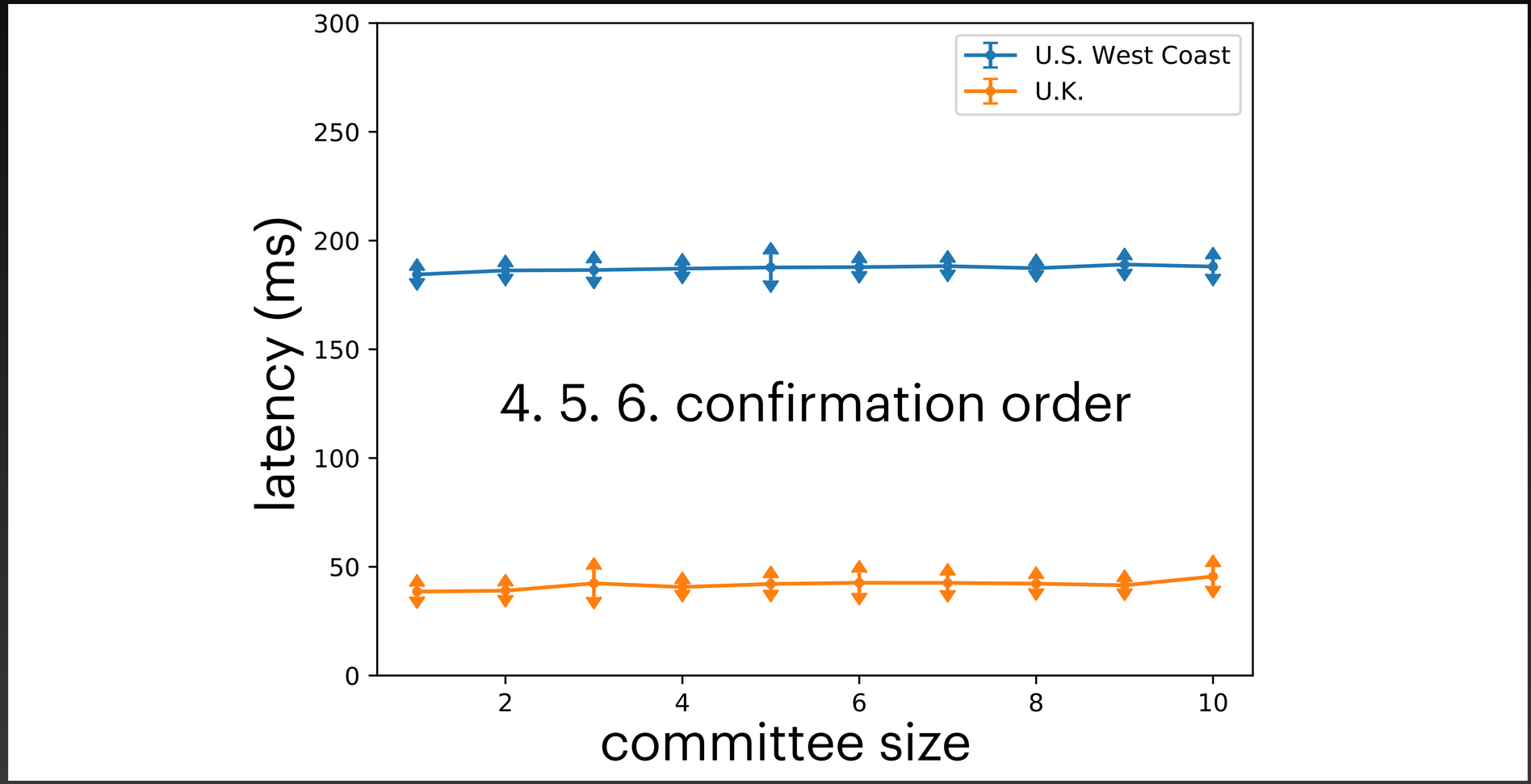
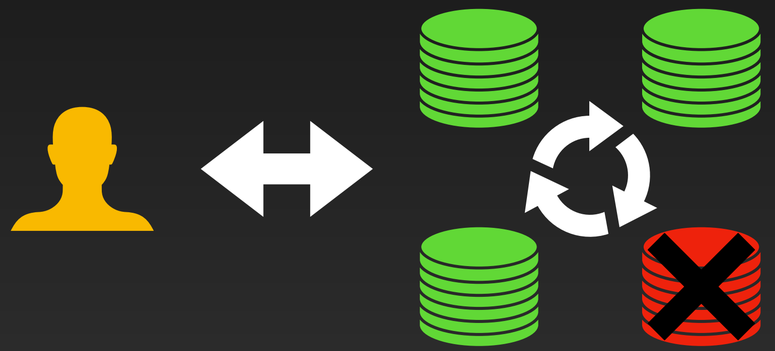


Worst-case efficiency

Blockchains



Bad leader can slow down the protocol

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No leader, nothing changes

Simplicity favors robustness and performance

Lesson I

Making it simple is hard

Lesson II

FastPay

The cost of simplicity

- Less than 4,000 LOC
- Over 1,500 Git commits
- Took 2.5 months to 3 engineers

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Deployment costs

- AWS m5d.8xlarge instance
- ~ 5 USD / hour

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Further works

- Checkpointing?
- Change the authorities?
- Privacy?

Conclusion

FastPay

- Based on Byzantine Consistent Broadcast
- Simple design, low latency, high capacity, very robust

- **Paper:** https://arxiv.org/abs/2003.11506
- **Code:** https://github.com/novifinancial/fastpay

asonnino@fb.com

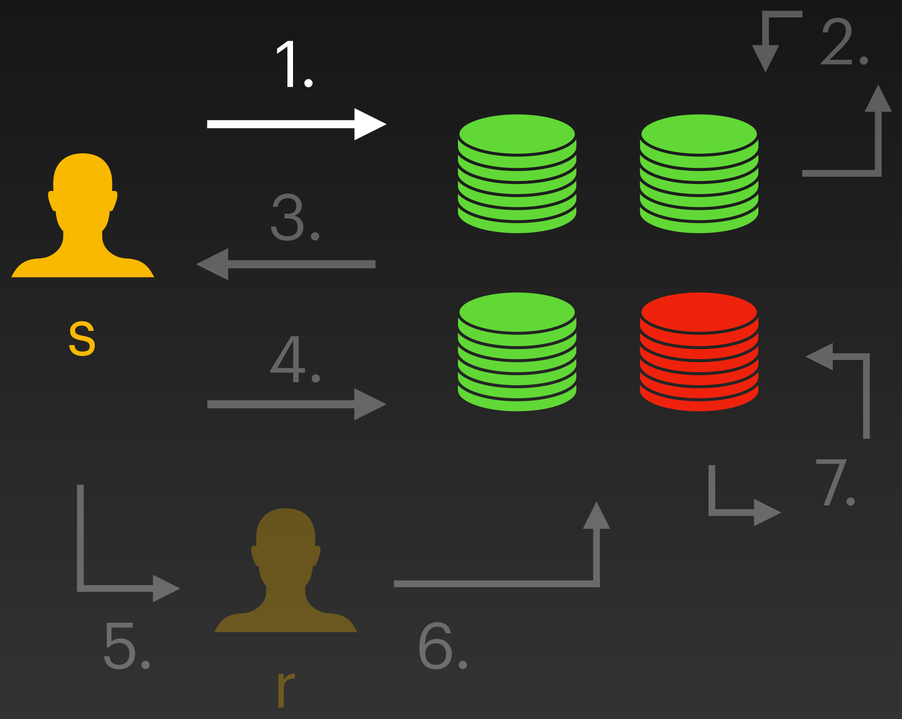
Alberto Sonnino

EXTRA

Protocol Details

From FastPay to FastPay

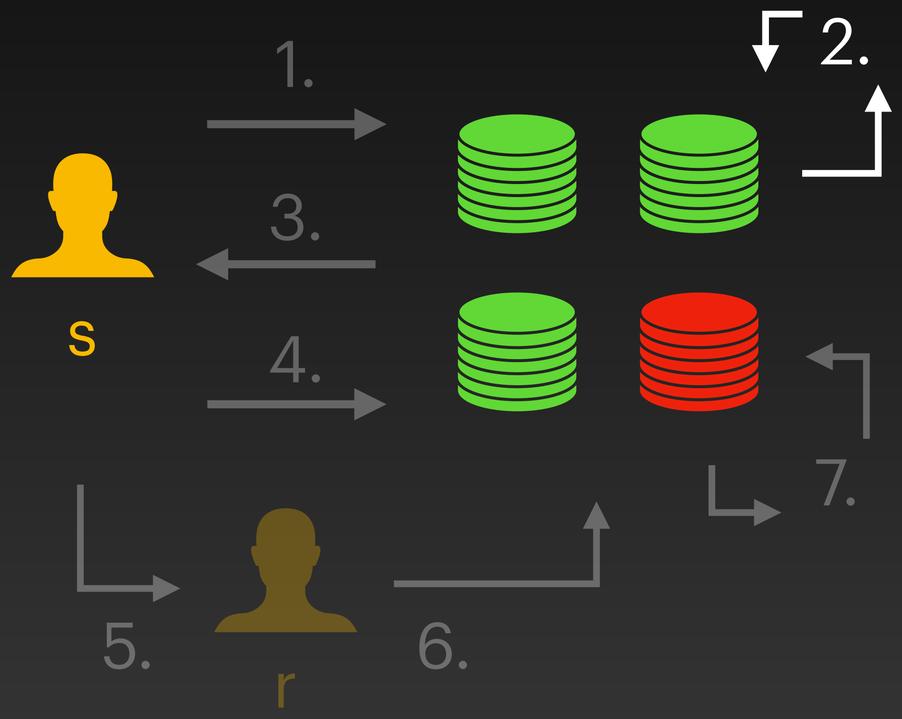
FastPay
Protocol details



1. transfer order

- Sender address
- Recipient address
- Amount
- Sequence number
- Sender's signature

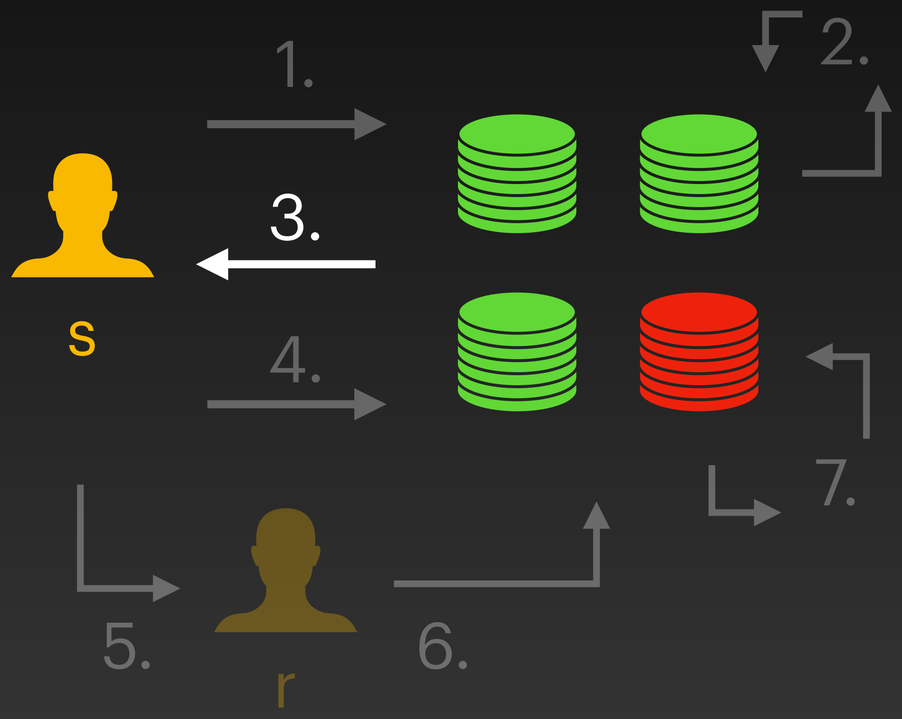
FastPay
Protocol details



2. verify

- The sender's signature
- No previous tx is pending
- The amount is positive
- Sequence number is as expected
- Balance is sufficient

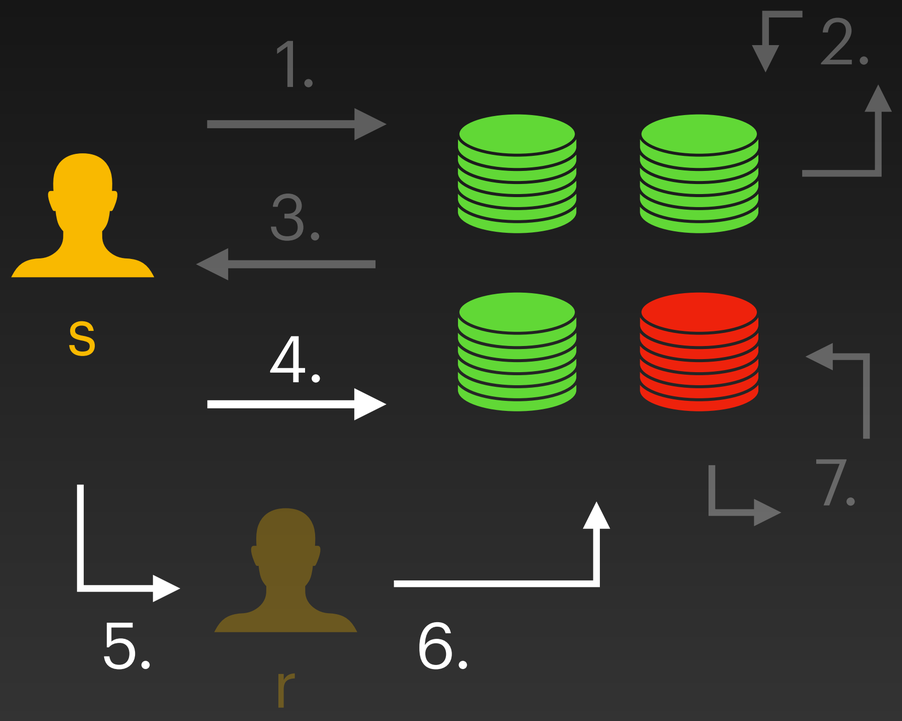
FastPay
Protocol details



3. signed transfer order

- Each authority signed the transfer order received in step 1.

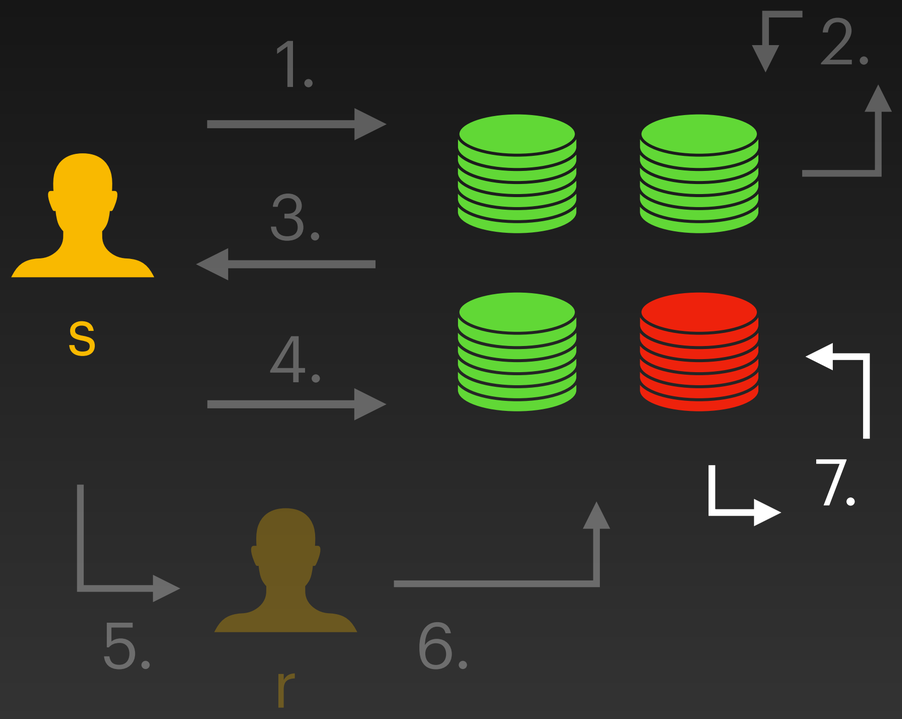
FastPay
Protocol details



4. 5. 6. confirmation order

- Collect enough signed transfer orders from step 2.

FastPay
Protocol details



7. update

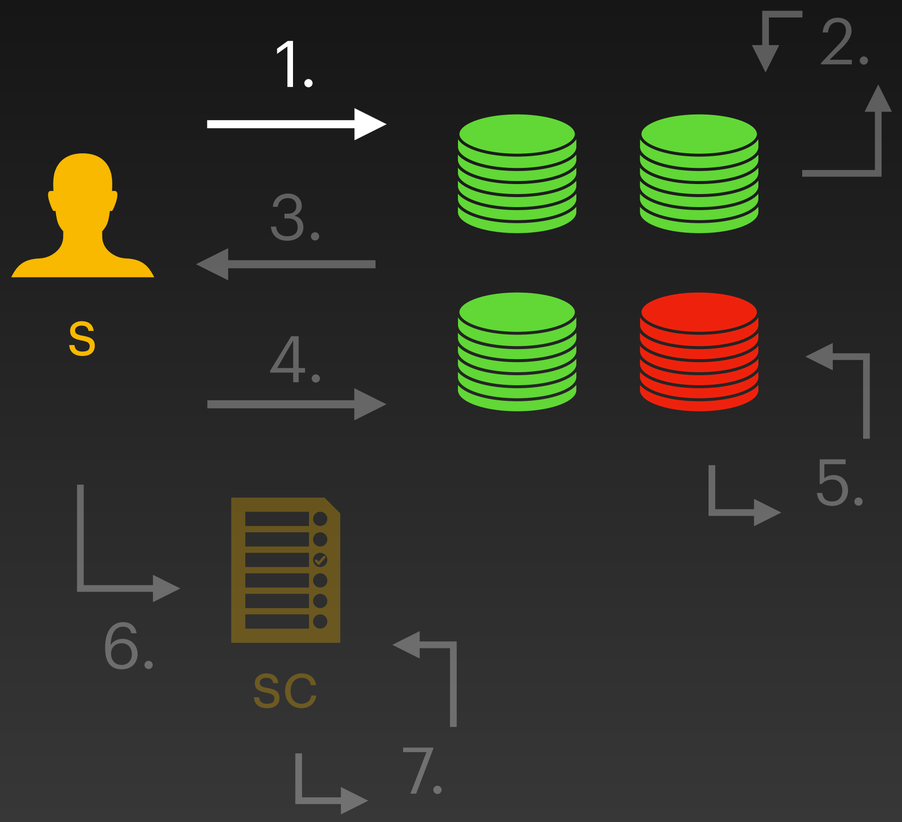
- Check there are enough signatures
- Decrease the senders' balance
- Increase the sequence number
- Set the pending order to None
- Increase the recipient's balance

Protocol Details

From FastPay to primary infrastructure

FastPay

From FastPay to primary infrastructure



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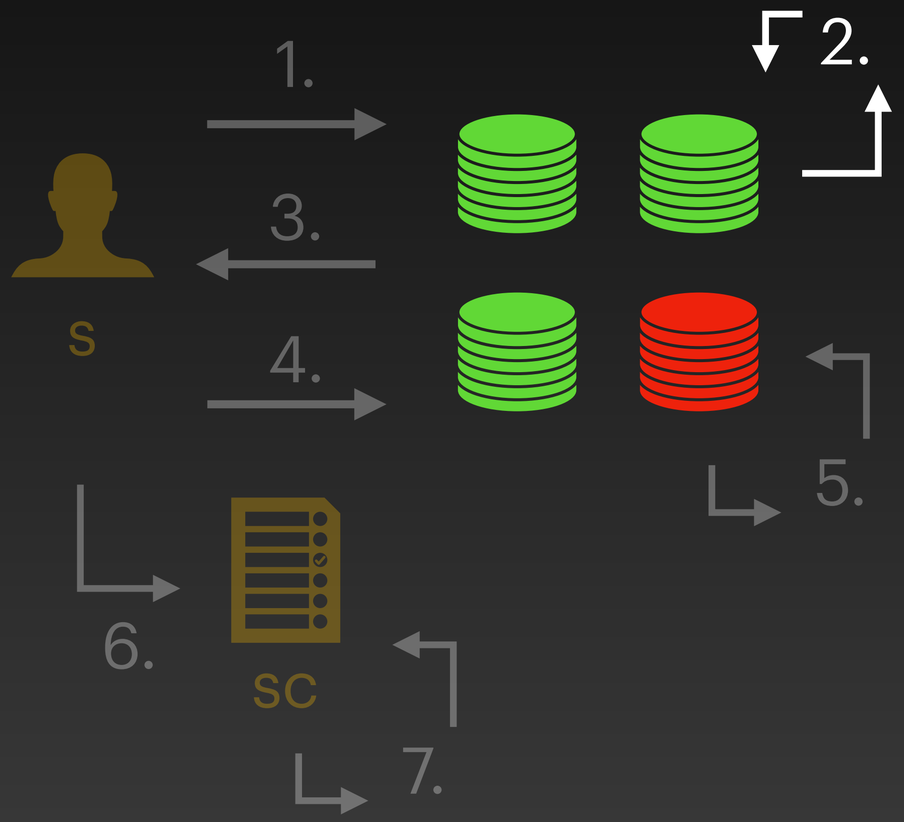

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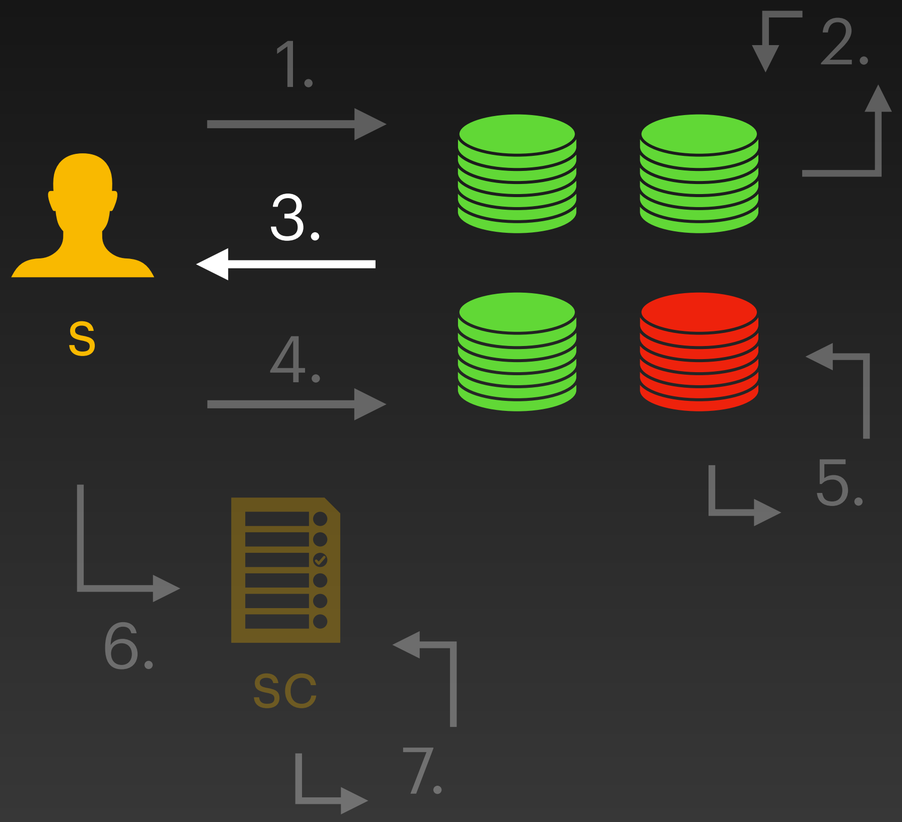

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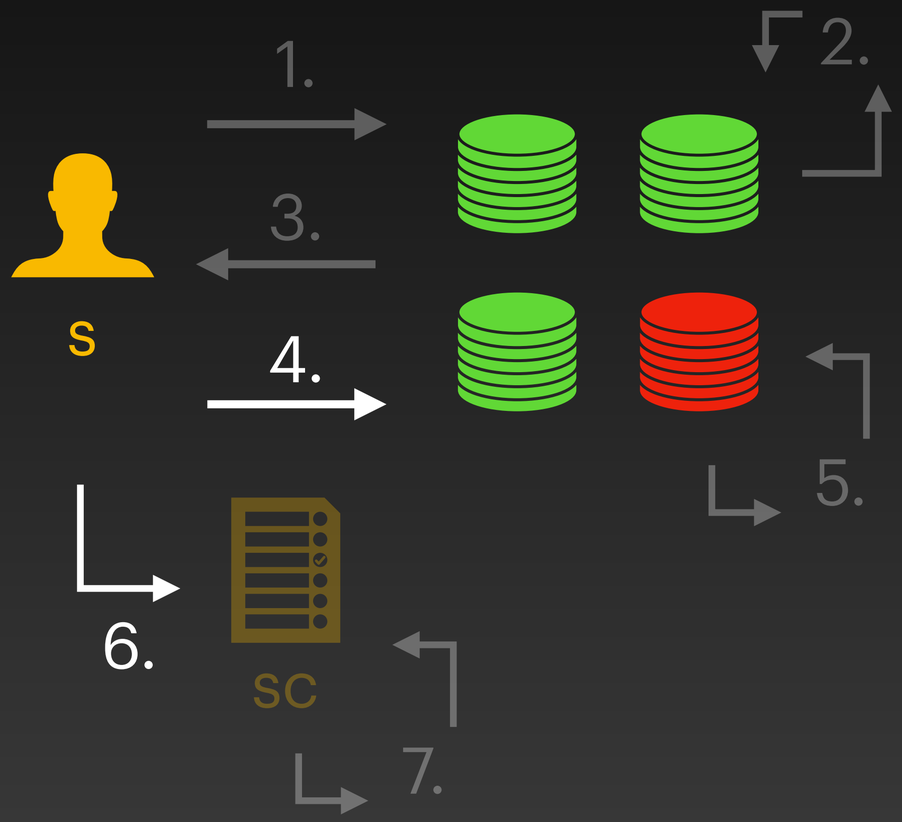

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FastPay

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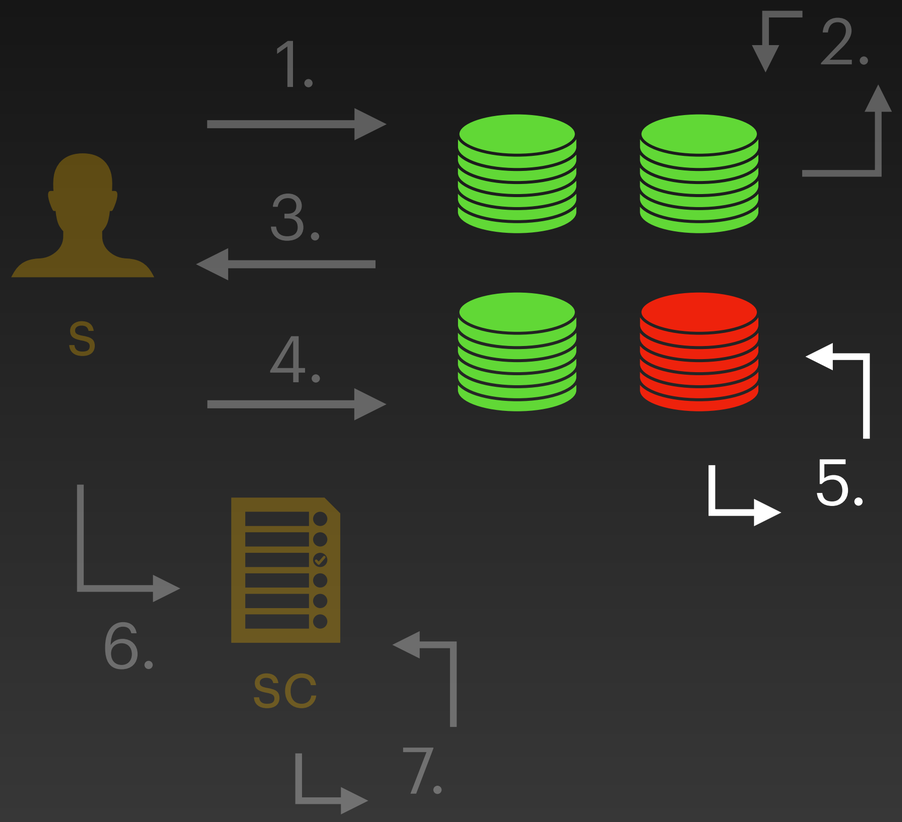

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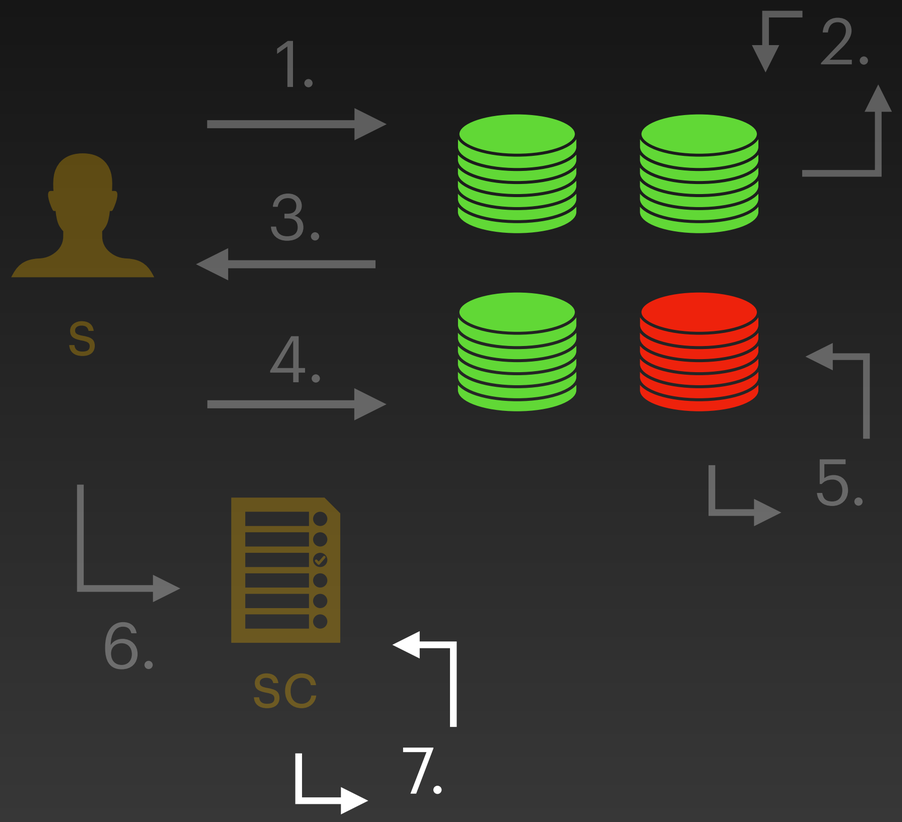


7. verify & update

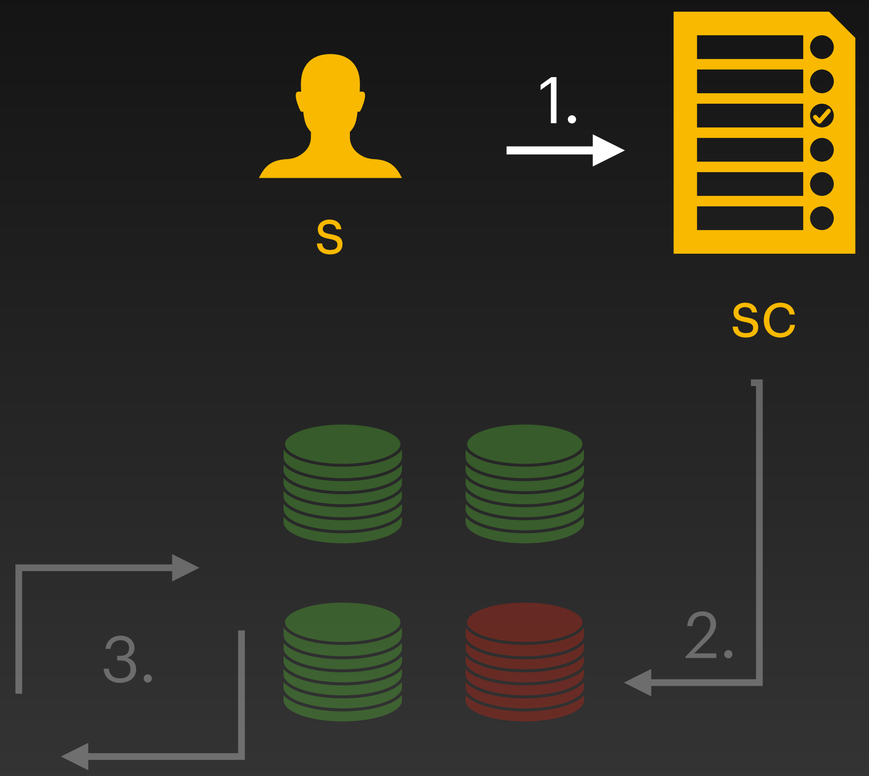
- Check sequence number is not on the redeem log
- Update the redeem log
- Transfer the amount to recipient

Protocol Details

From primary infrastructure to FastPay

FastPay

From primary infrastructure to FastPay

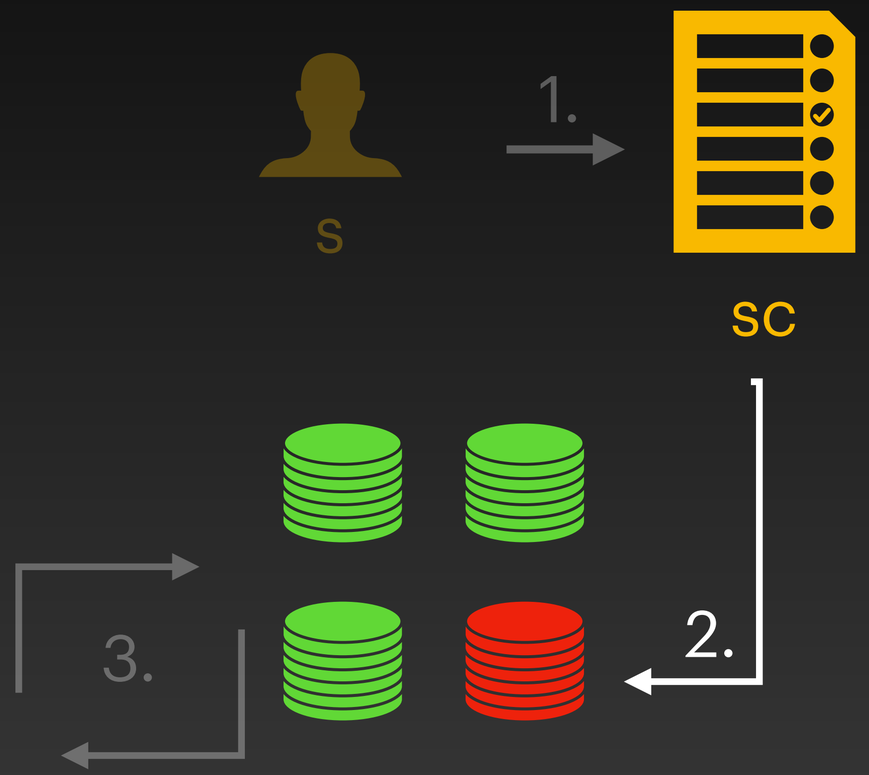


1. funding transaction

- FastPay recipient
- All fields required by the primary infrastructure (and the amount)

FastPay

From primary infrastructure to FastPay

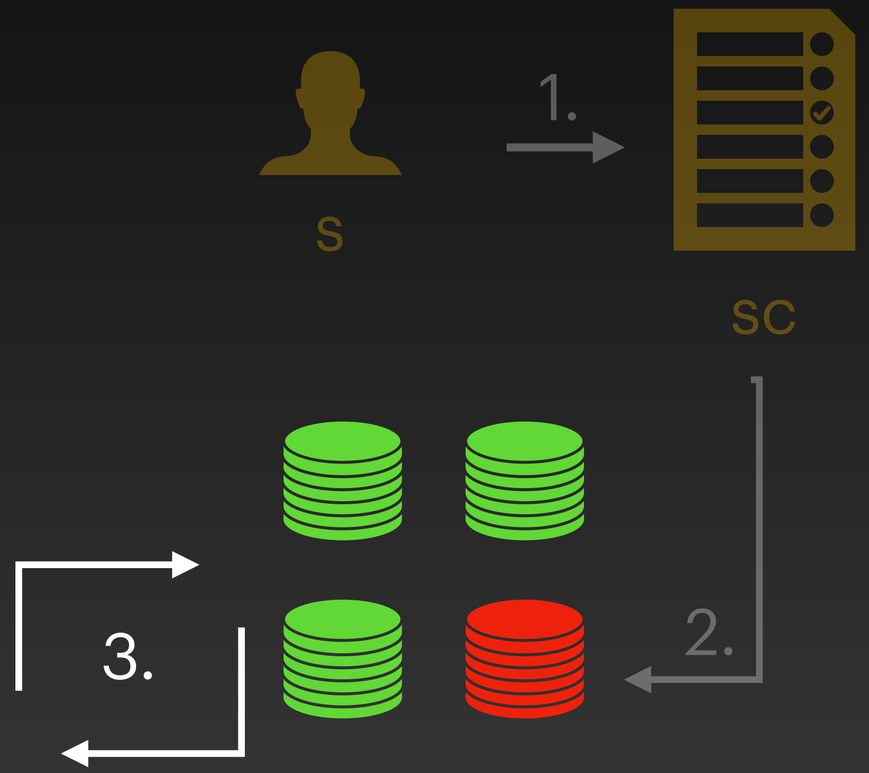


2. synchronization order

- Read the transaction on the primary infrastructure (once it is sequenced)

FastPay

From primary infrastructure to FastPay



3. update & verify

- Check last primary tx index
- Increment last primary tx index
- Create a FastPay account for the recipient (if needed)
- Increase recipient's balance