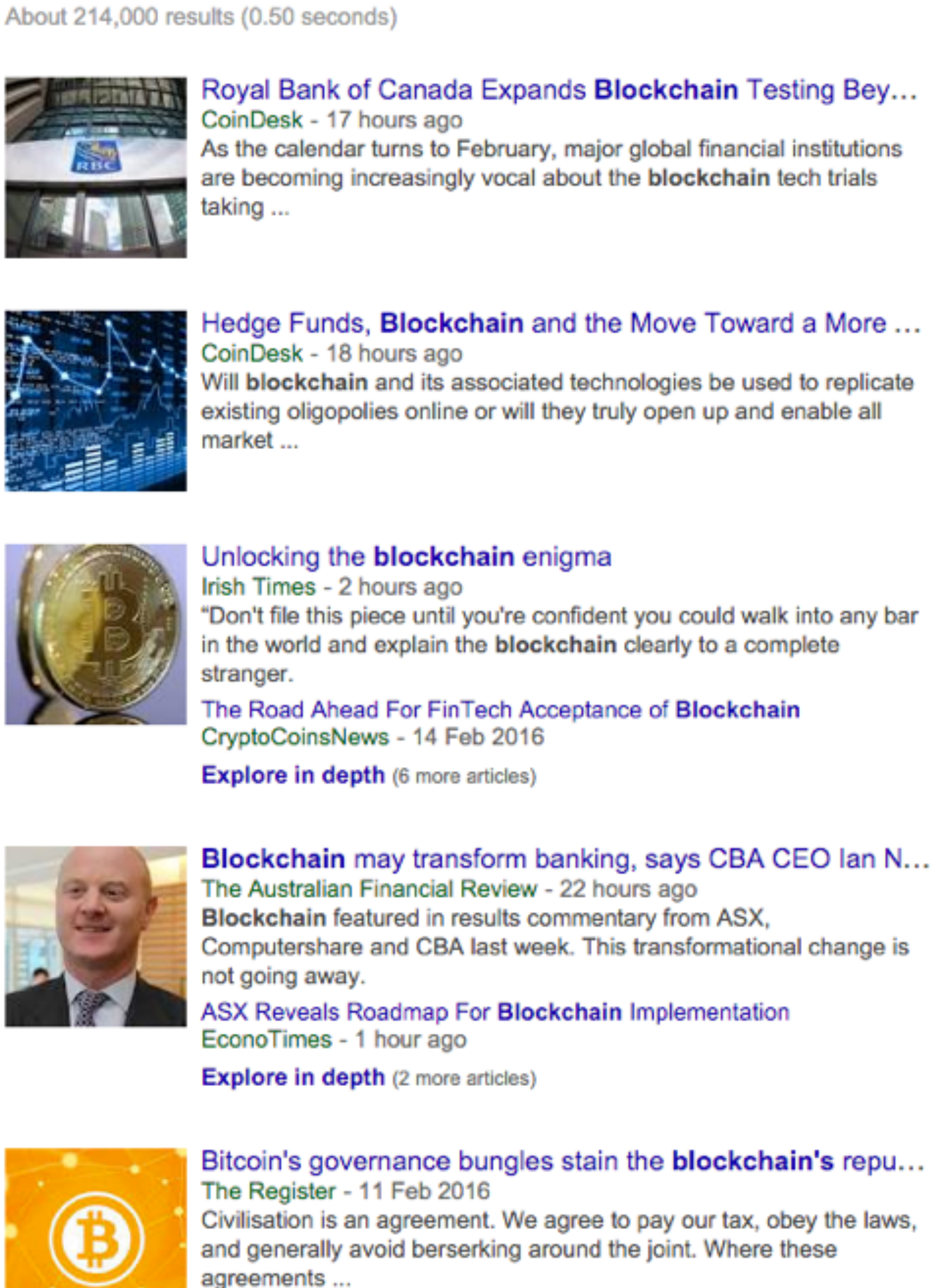
Centrally Banked Cryptocurrencies

George Danezis (University College London)

Sarah Meiklejohn (University College London)

who’s interested in ‘blockchain’?



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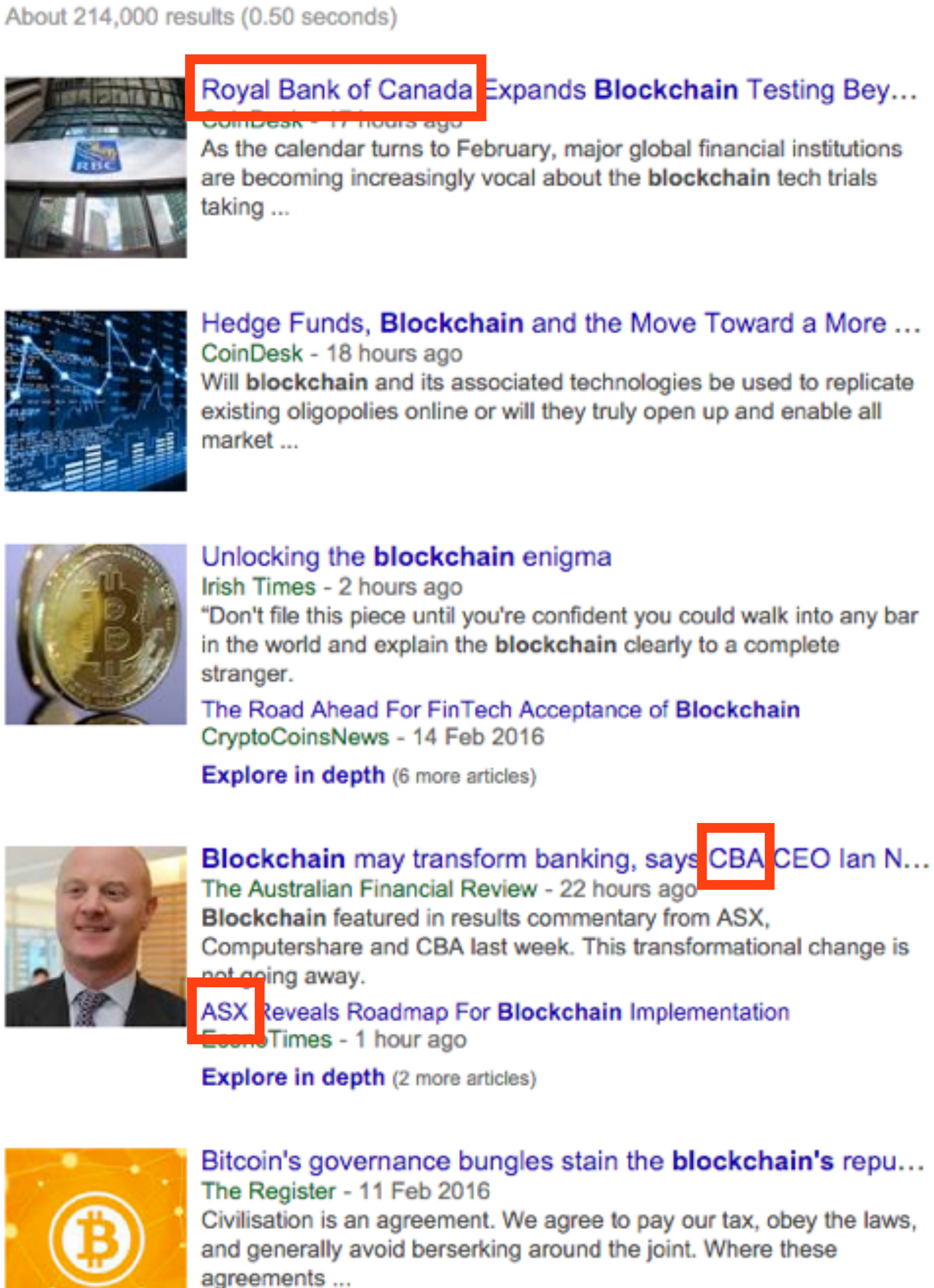

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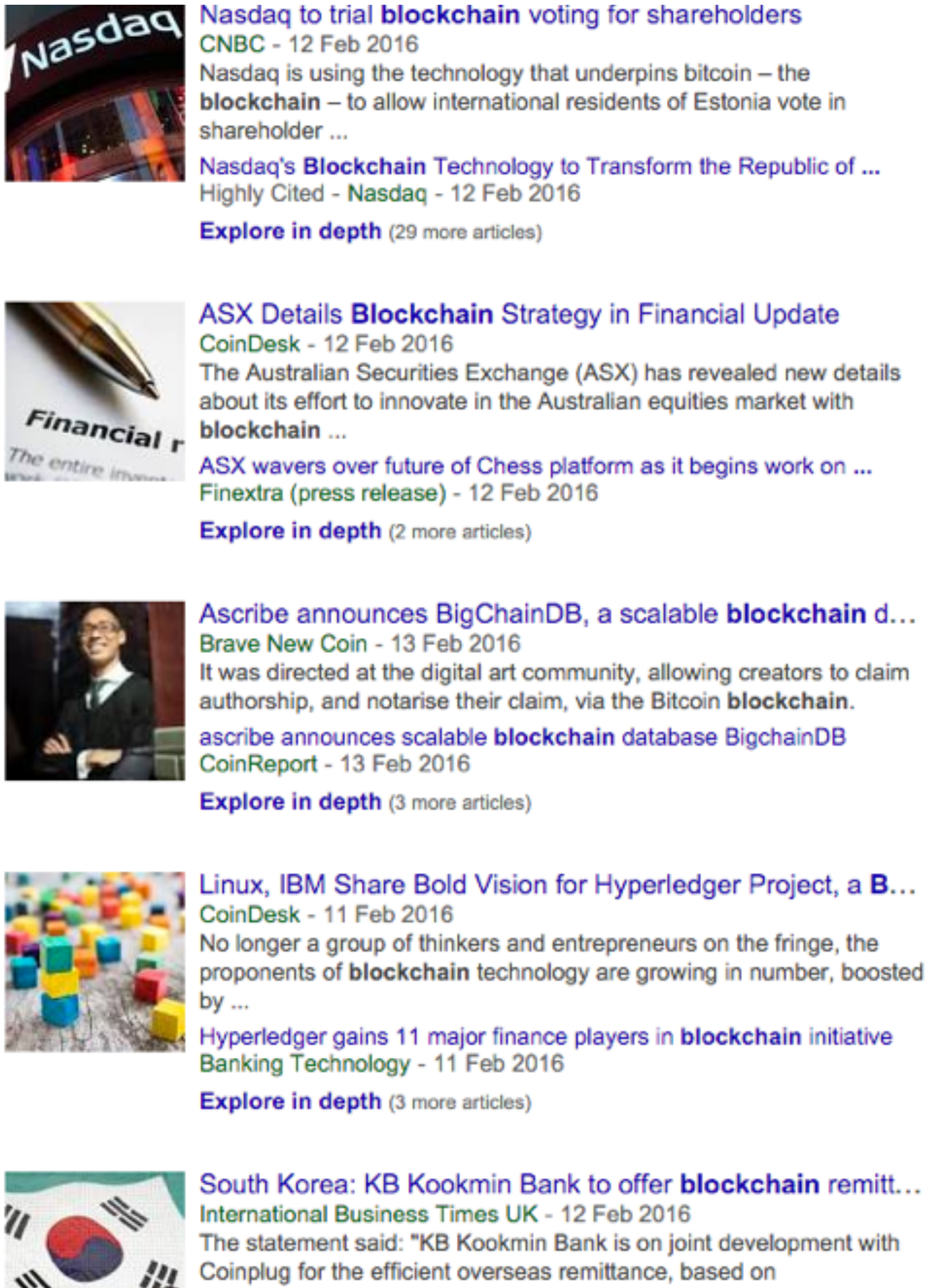

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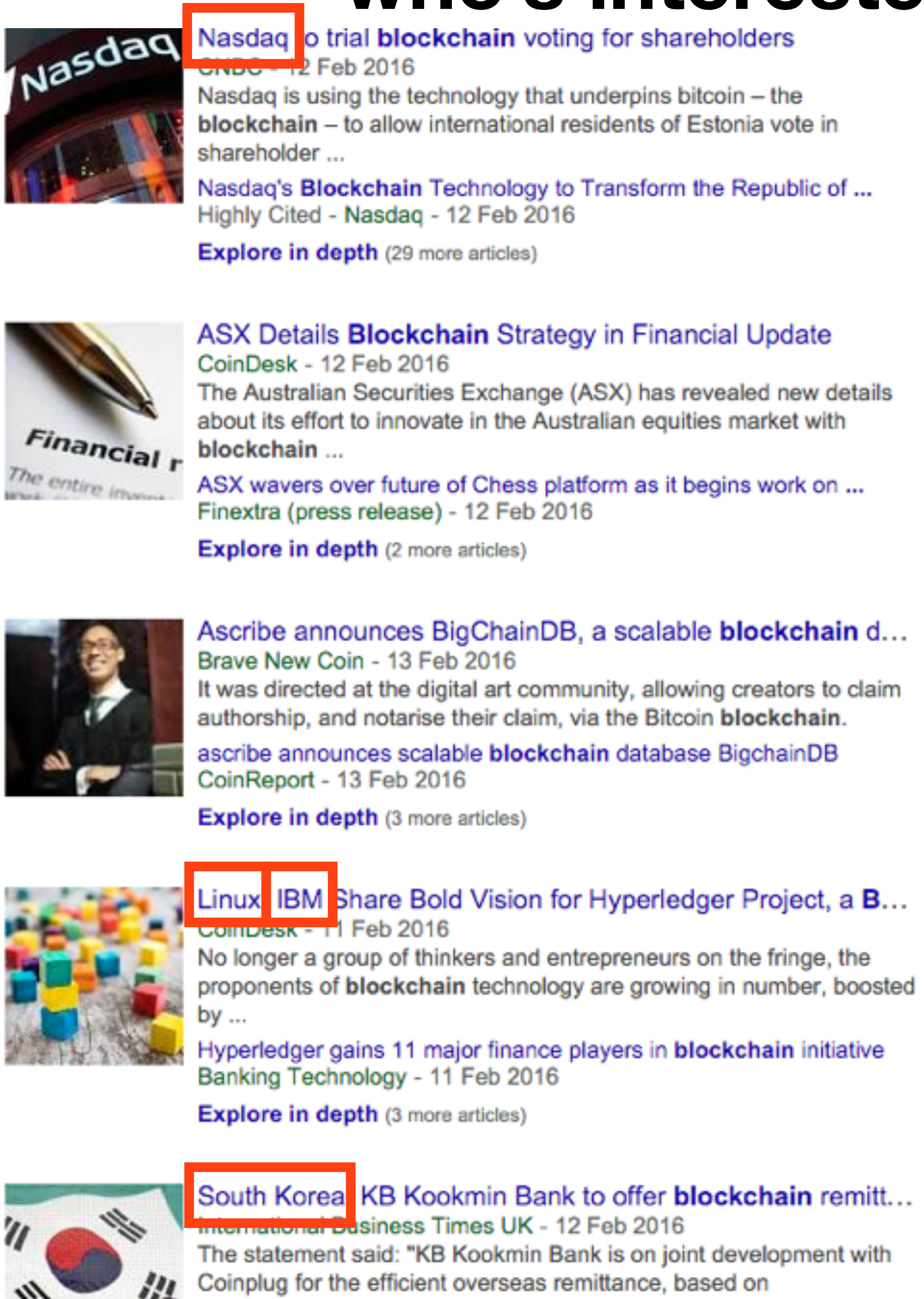

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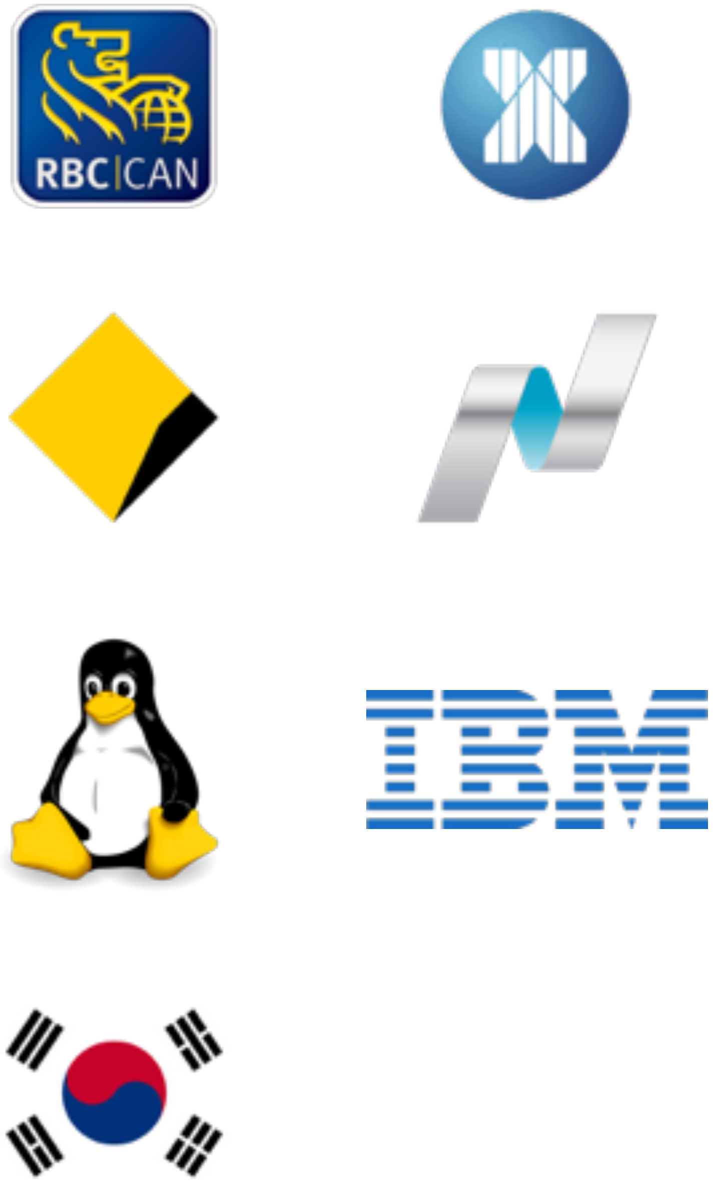

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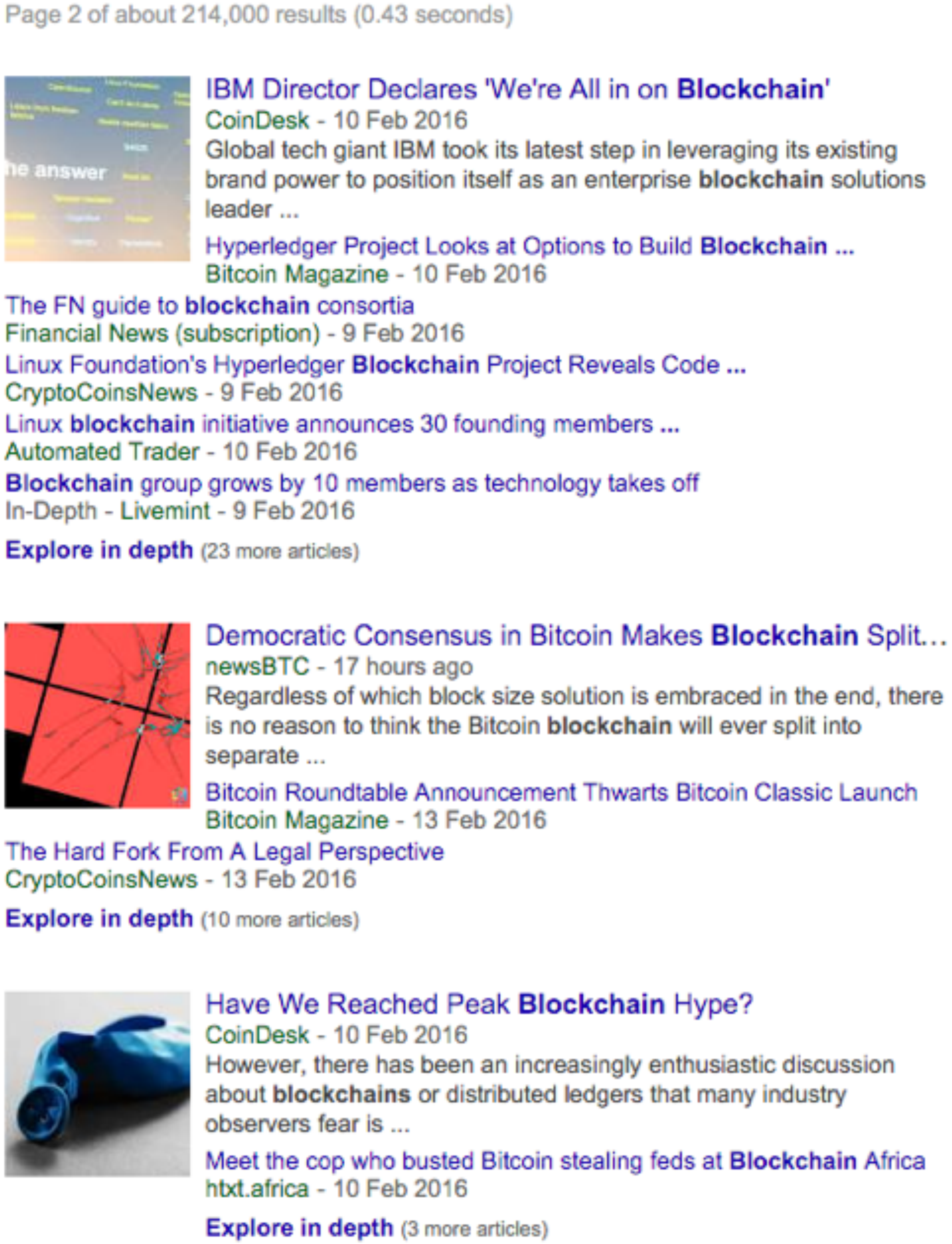

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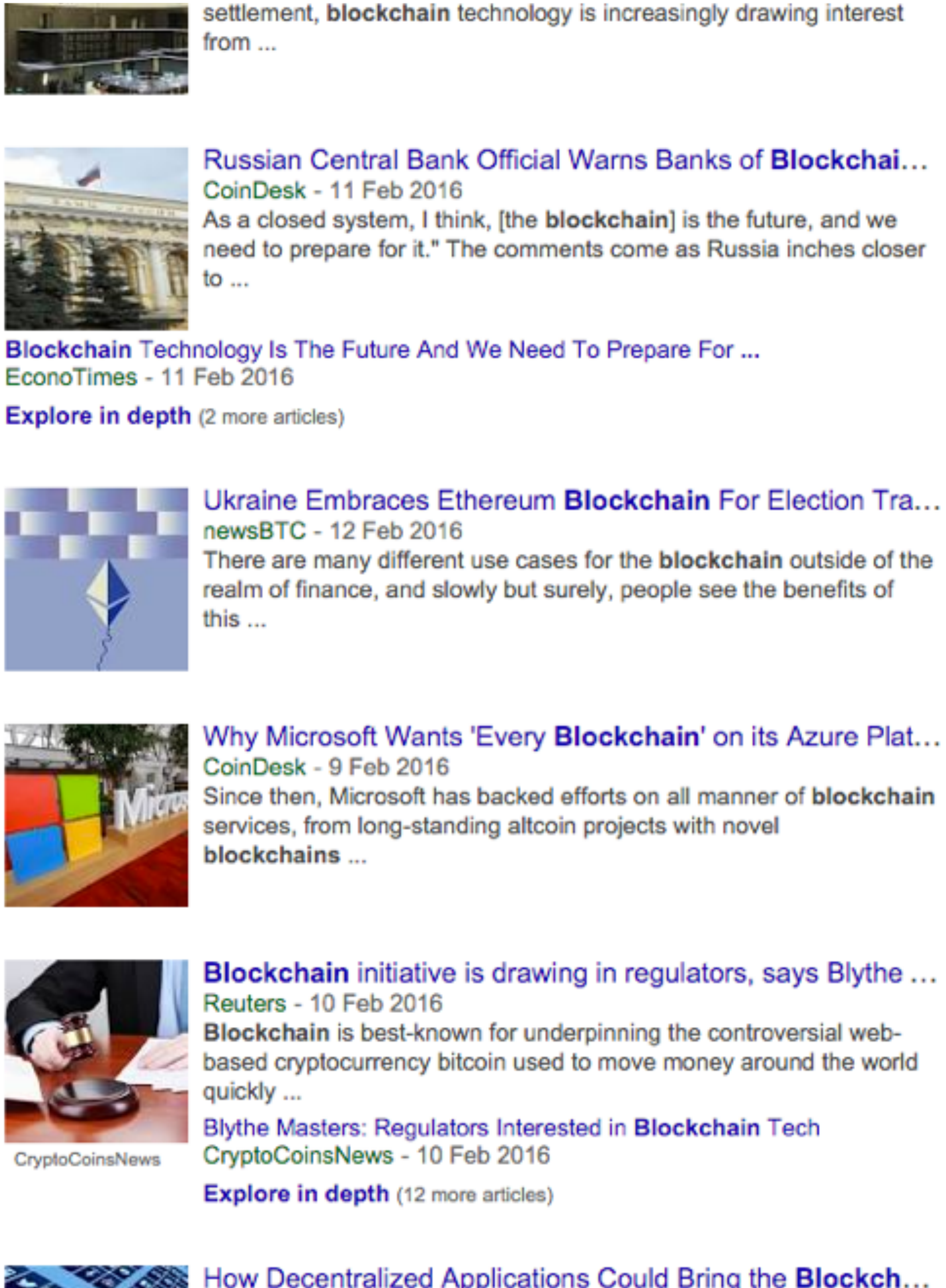

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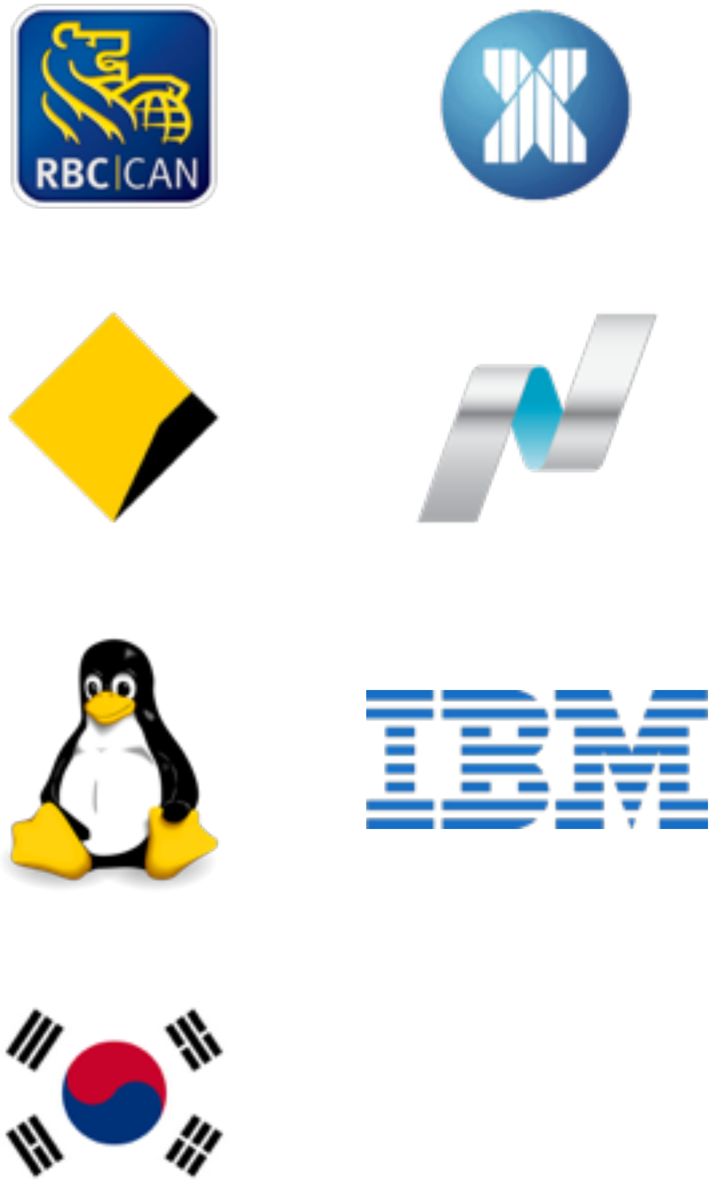

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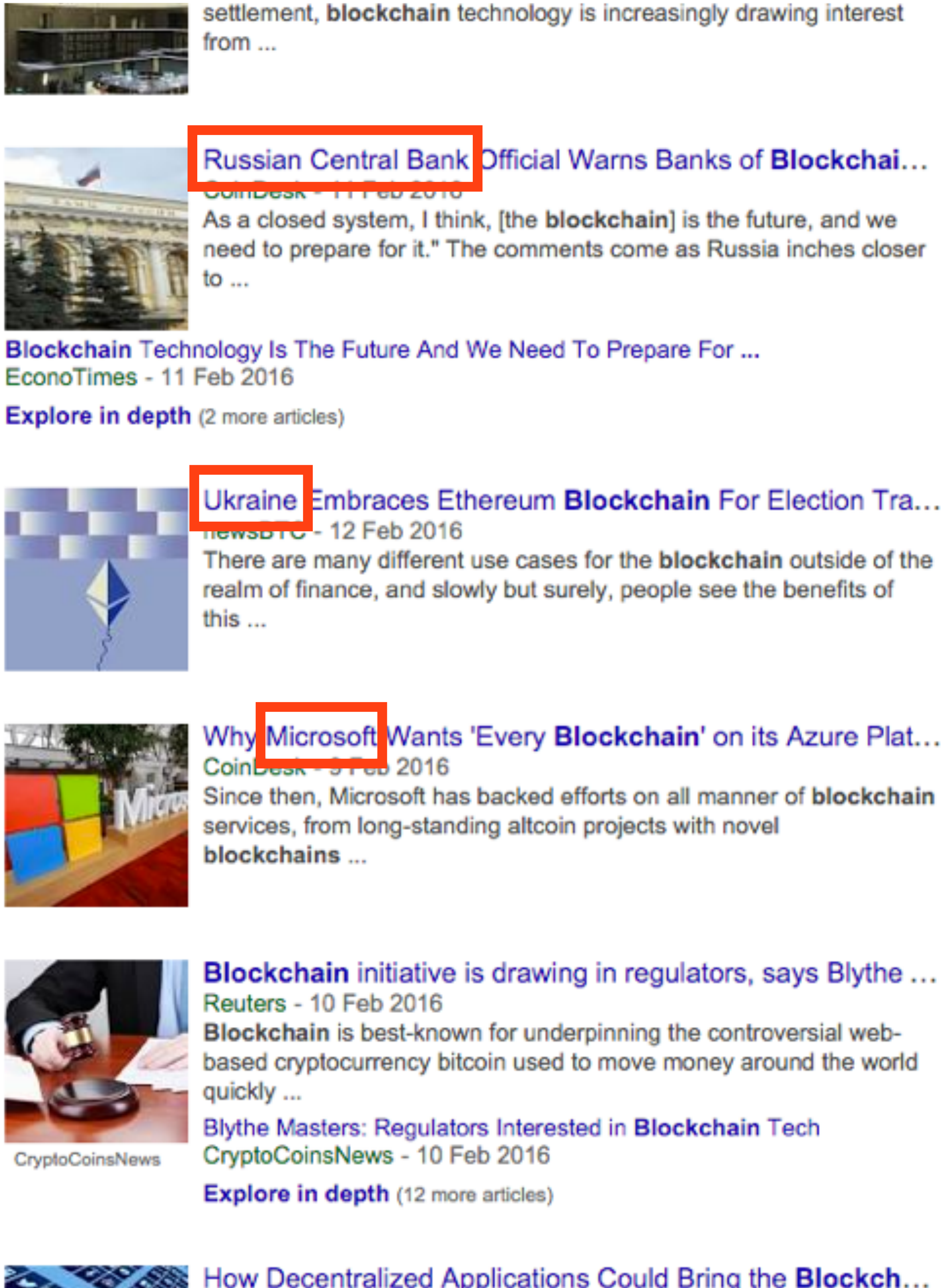

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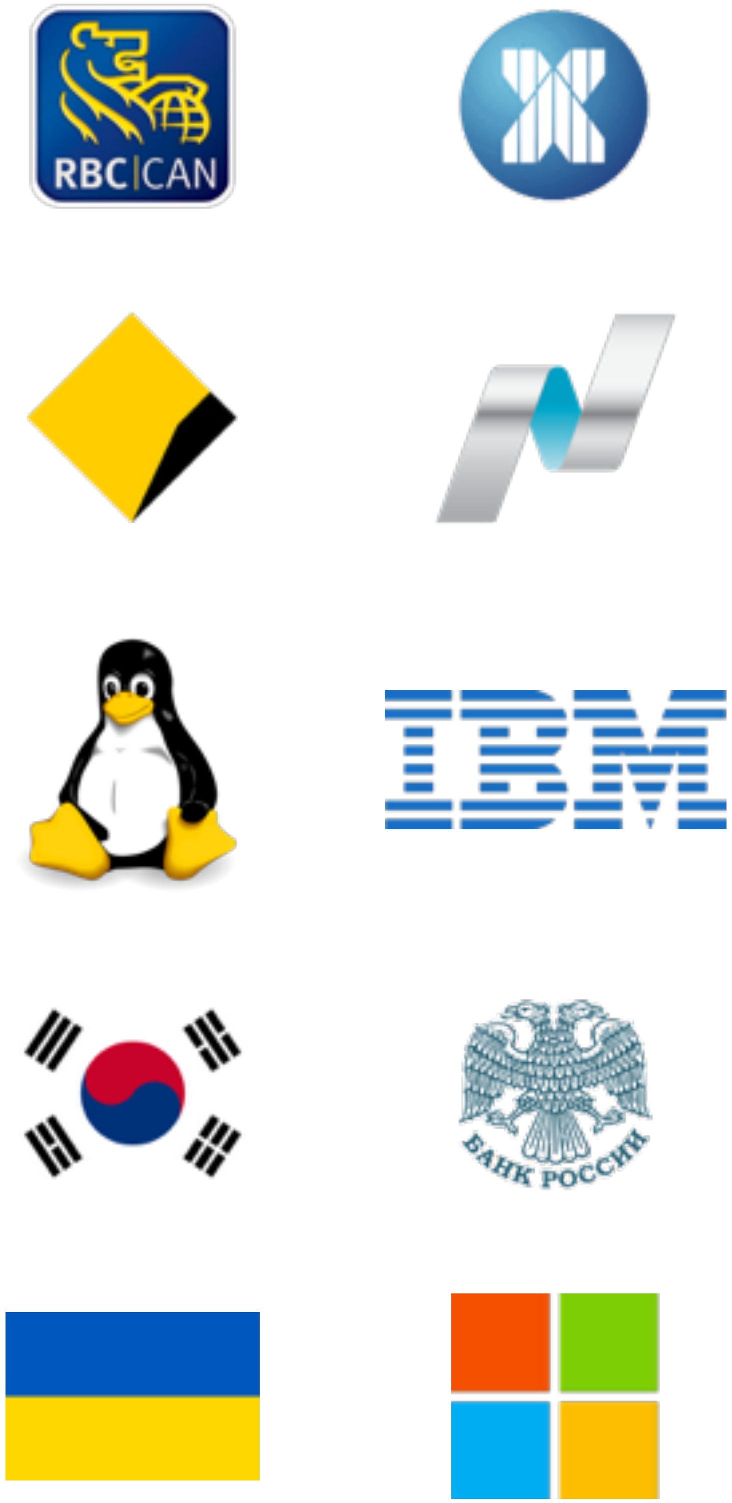

fully decentralized cryptocurrencies

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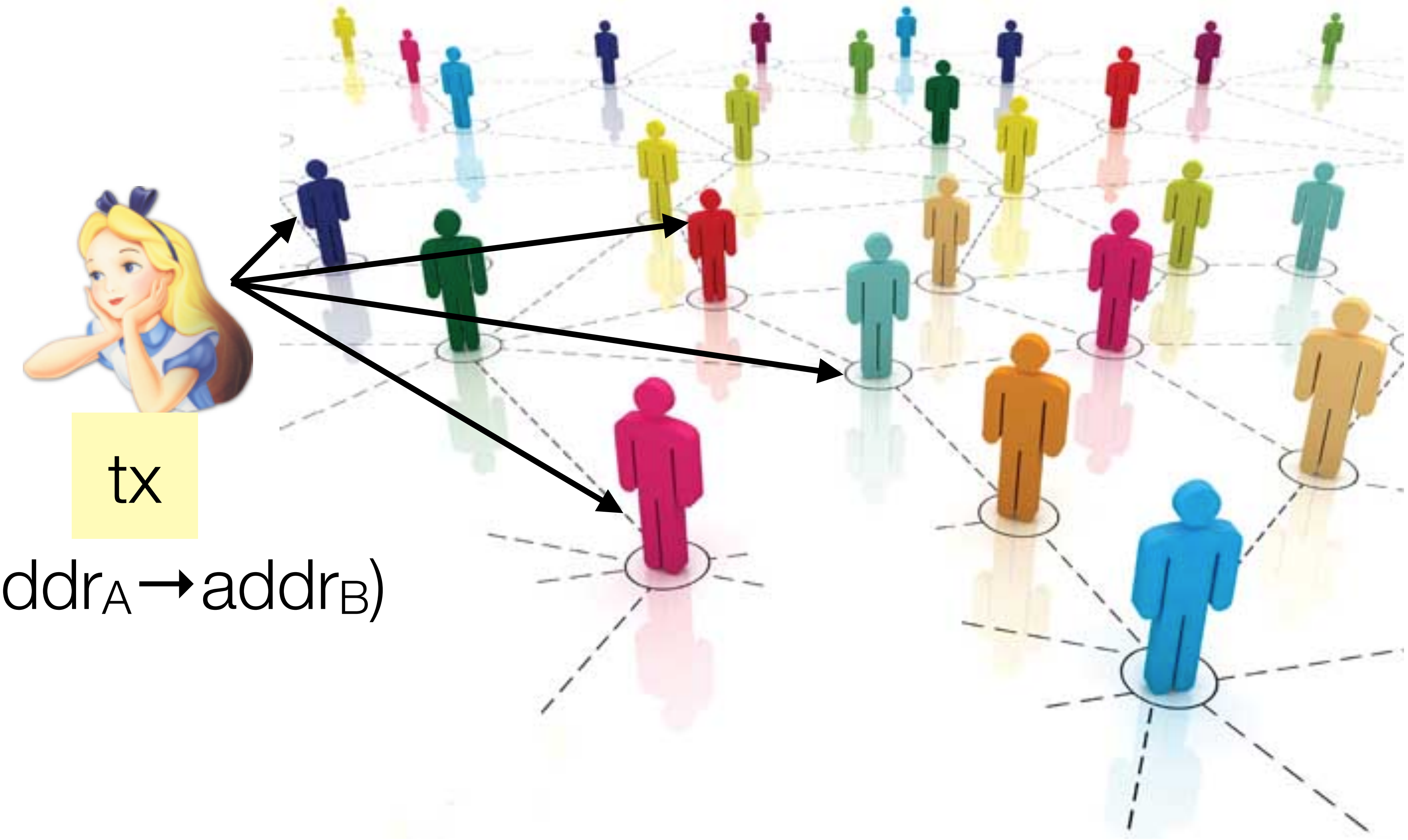
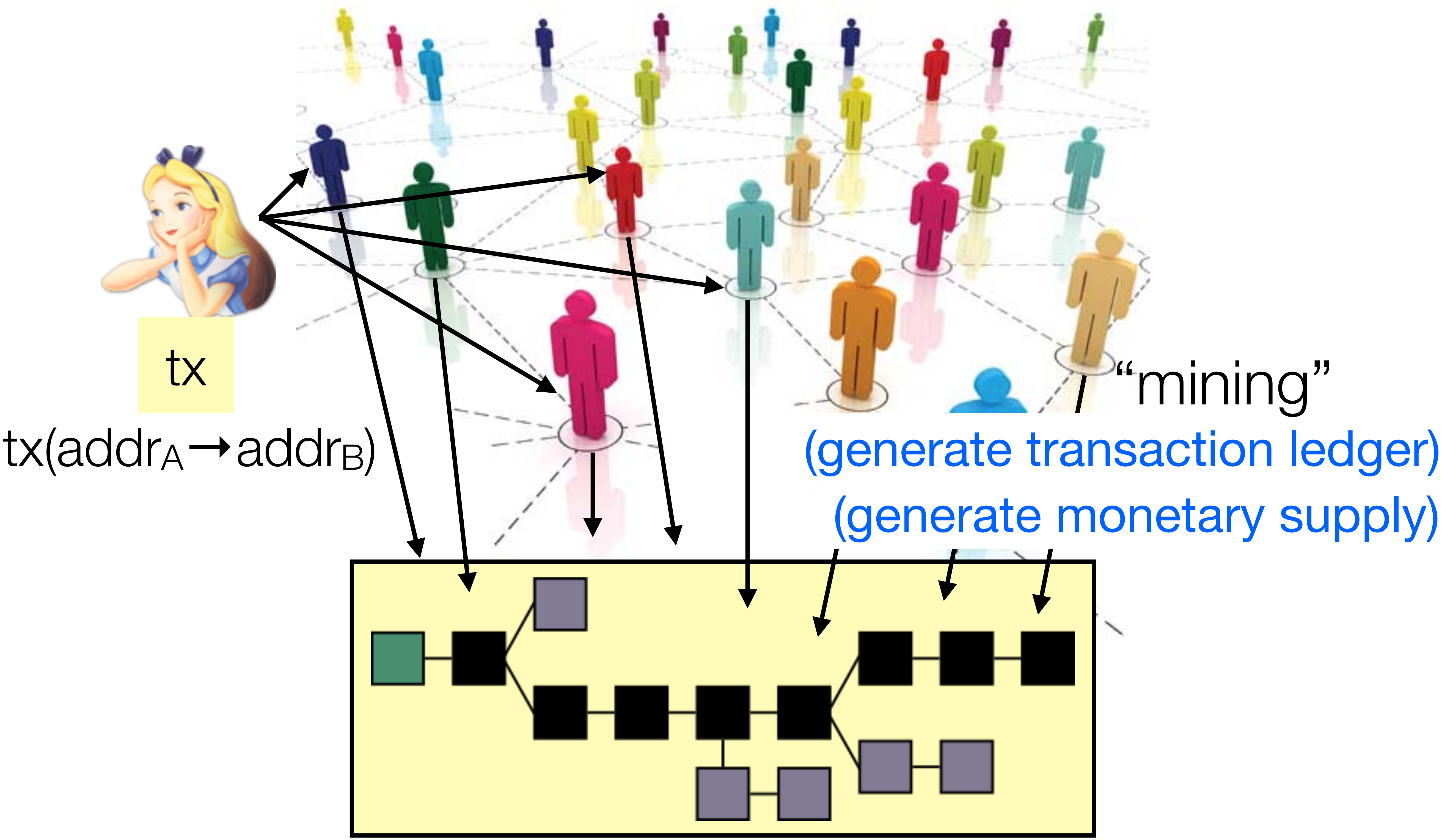


tx

$\text{tx}(\text{addr}_A \rightarrow \text{addr}_B)$

fully decentralized cryptocurrencies



tx

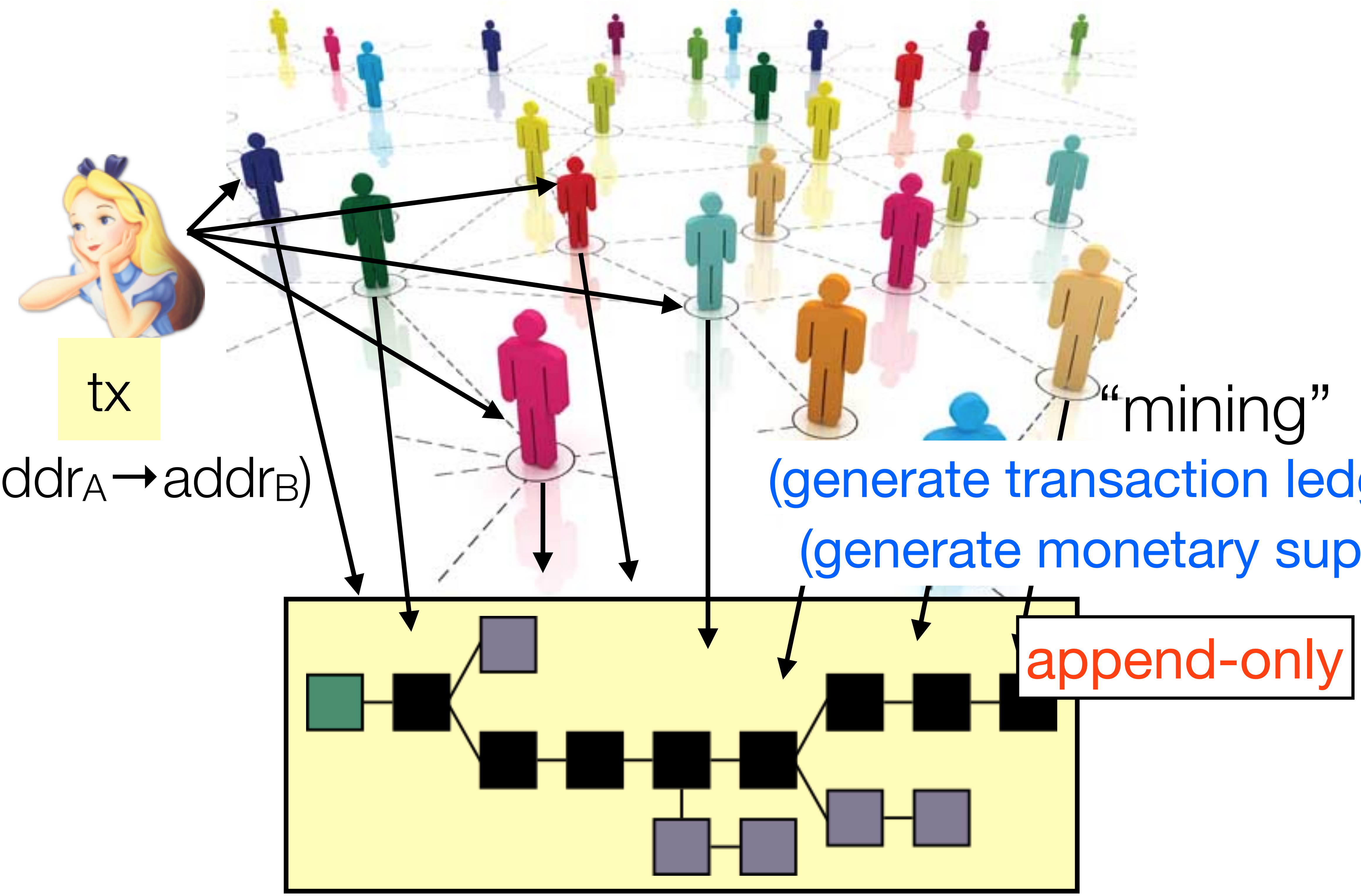
tx($addr_A$→$addr_B$)

“mining”

(generate transaction ledger)

(generate monetary supply)

fully decentralized cryptocurrencies



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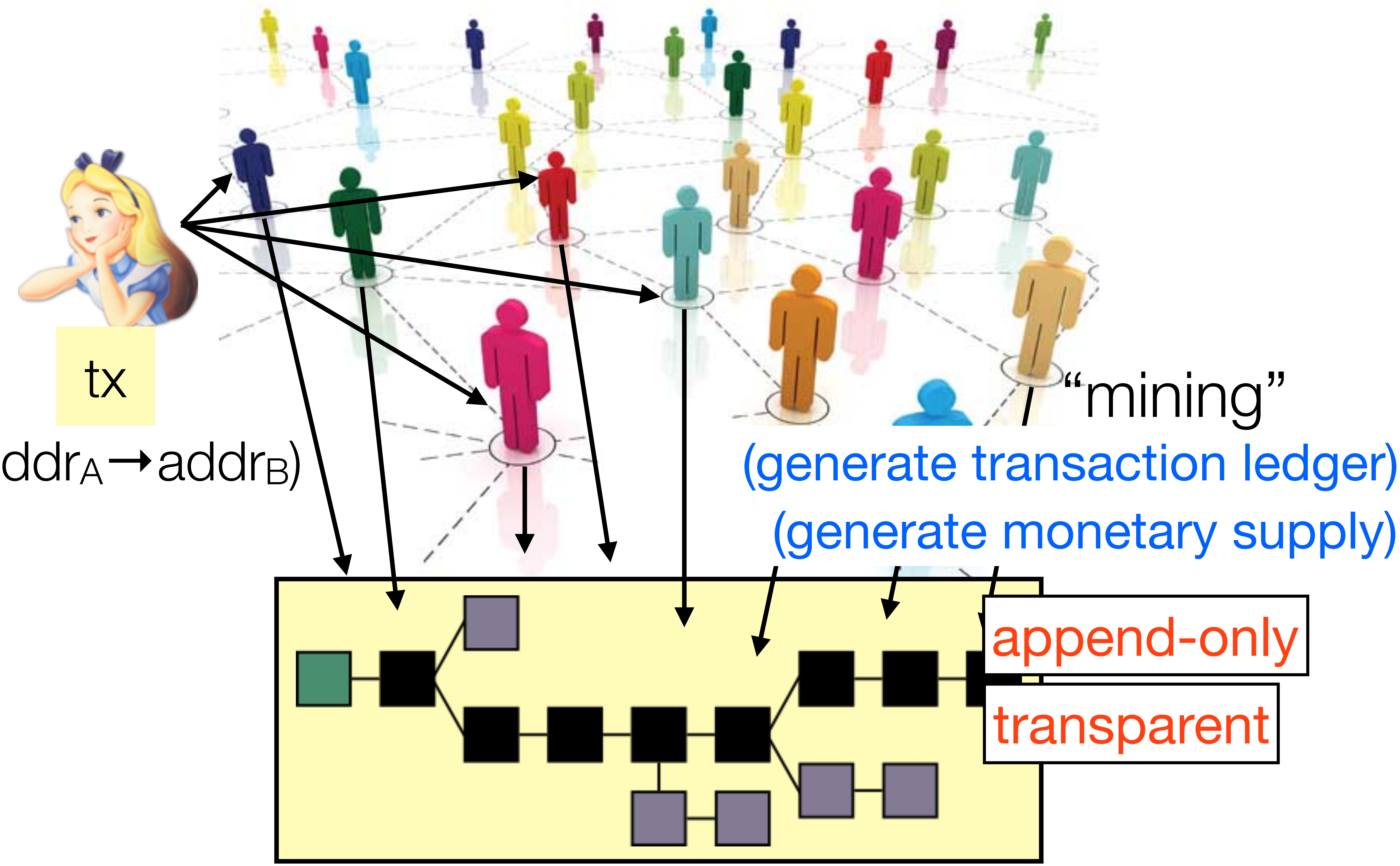
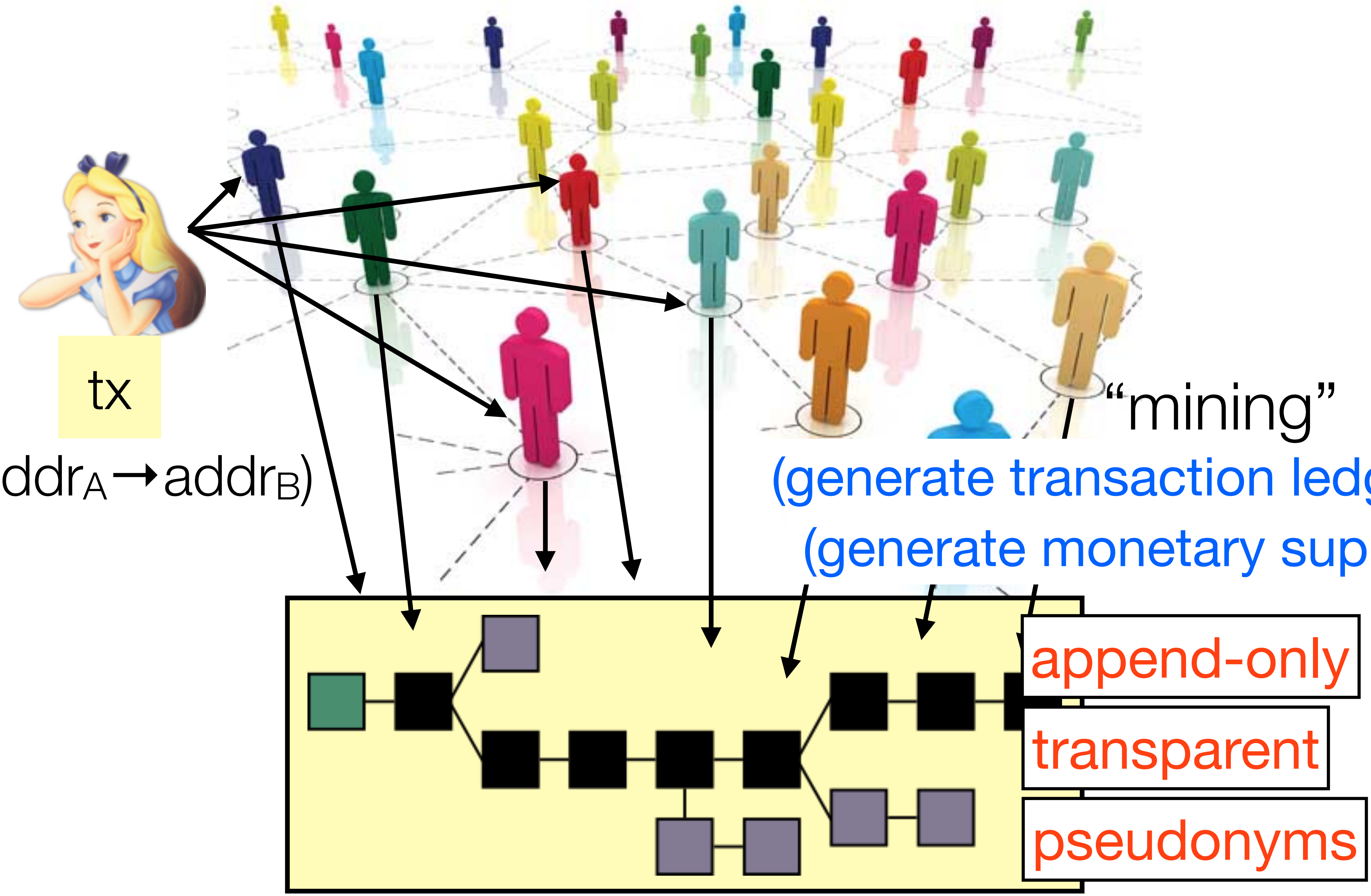
(generate monetary supply)

append-only

fully decentralized cryptocurrencies



fully decentralized cryptocurrencies



tx

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“mining”

(generate transaction ledger)

(generate monetary supply)

append-only

transparent

pseudonyms

issues with Bitcoin

no control over monetary policy

hashing rates are out of control

incentive structure is messed up

attacks on mining

issues with Bitcoin

no control over monetary policy

hashing rates are out of control

incentive structure is messed up

attacks on mining

not suitable for most applications!

RSCoin

		RSCoin	
monetary supply	decentral	central	central

		RSCoin	
monetary supply	decentral	central	central
ledger	decentral	distribute	central

		RSCoin	
monetary supply	decentral	central	central
ledger	decentral	distribute	central
transparent?	y	y (or n)	n

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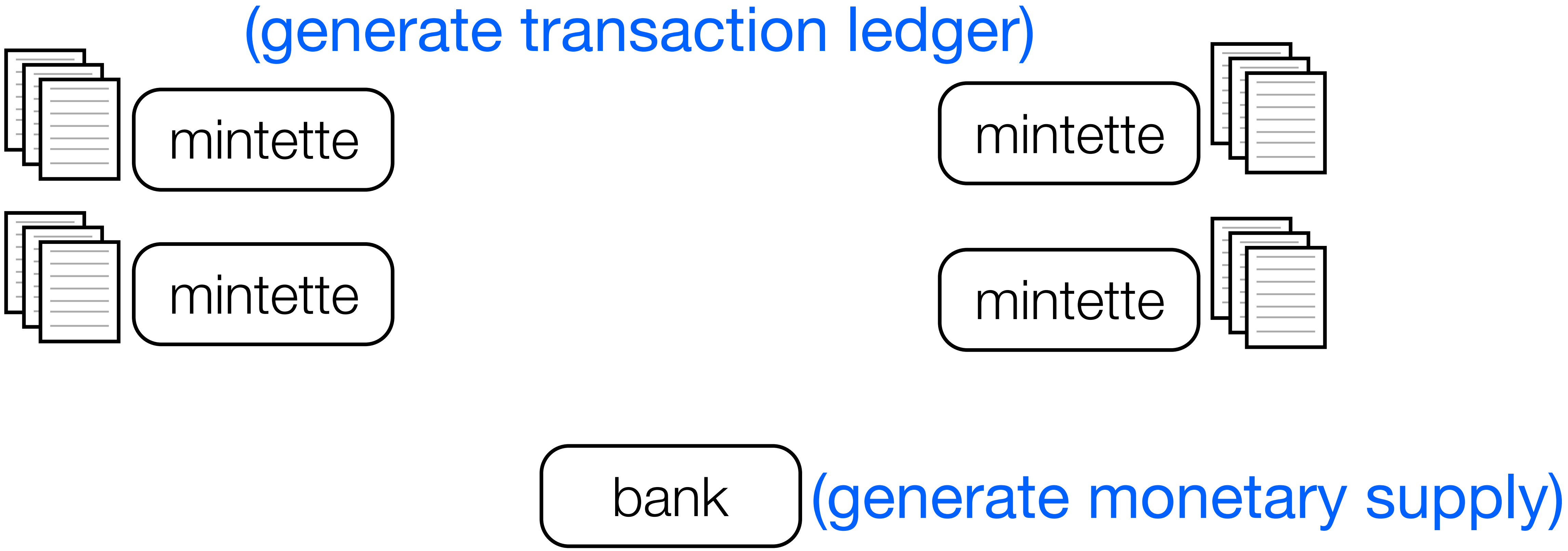
monetary supply	decentral	central	central
ledger	decentral	distribute	central
transparent?	y	y (or n)	n
pseudonyms?	y	y (or n)	n
computation	high!	low	low

bank (generate monetary supply)



(generate transaction ledger)

mintette

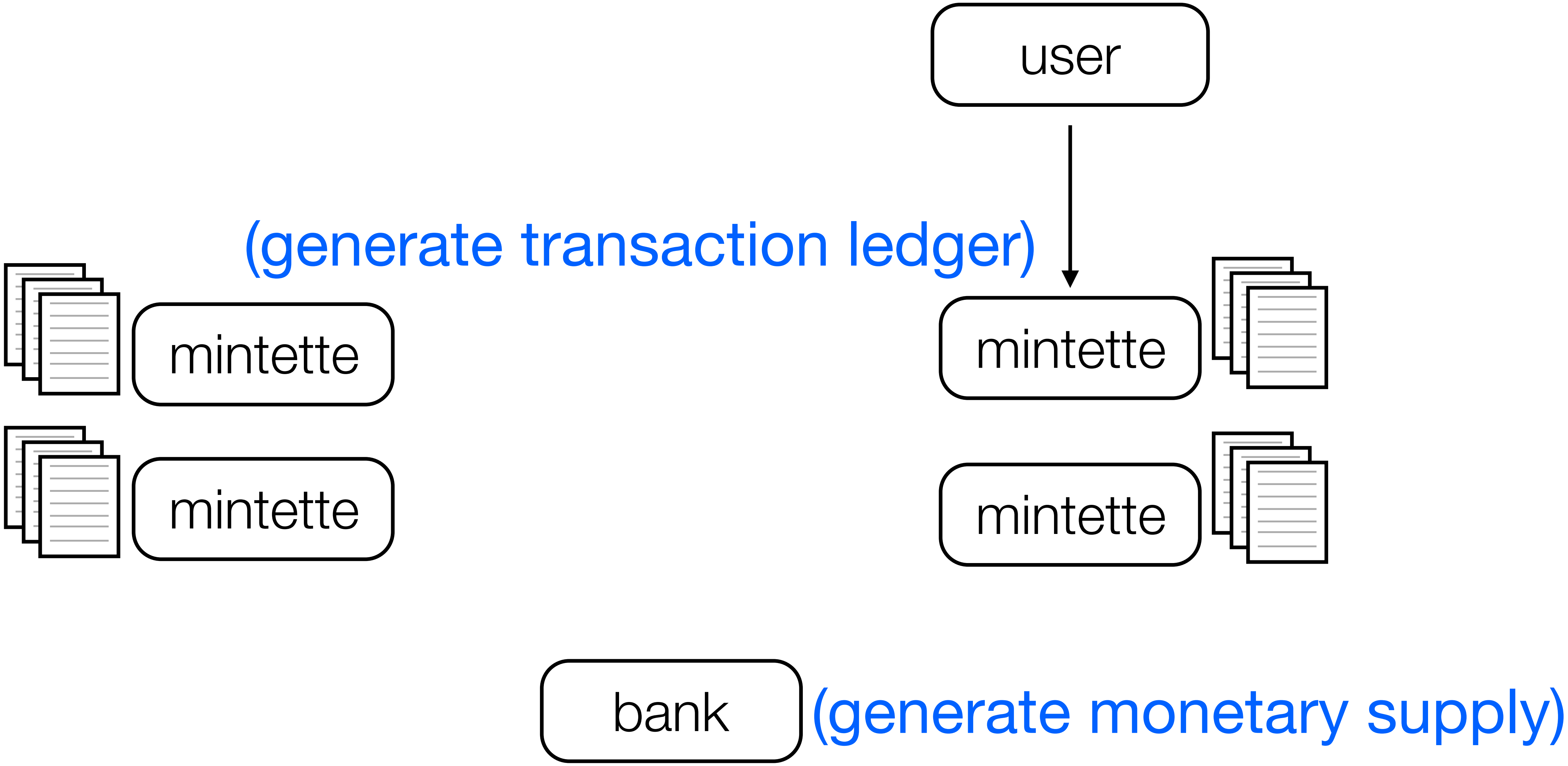
mintette

mintette

mintette

bank

(generate monetary supply)



user

(generate transaction ledger)

mintette

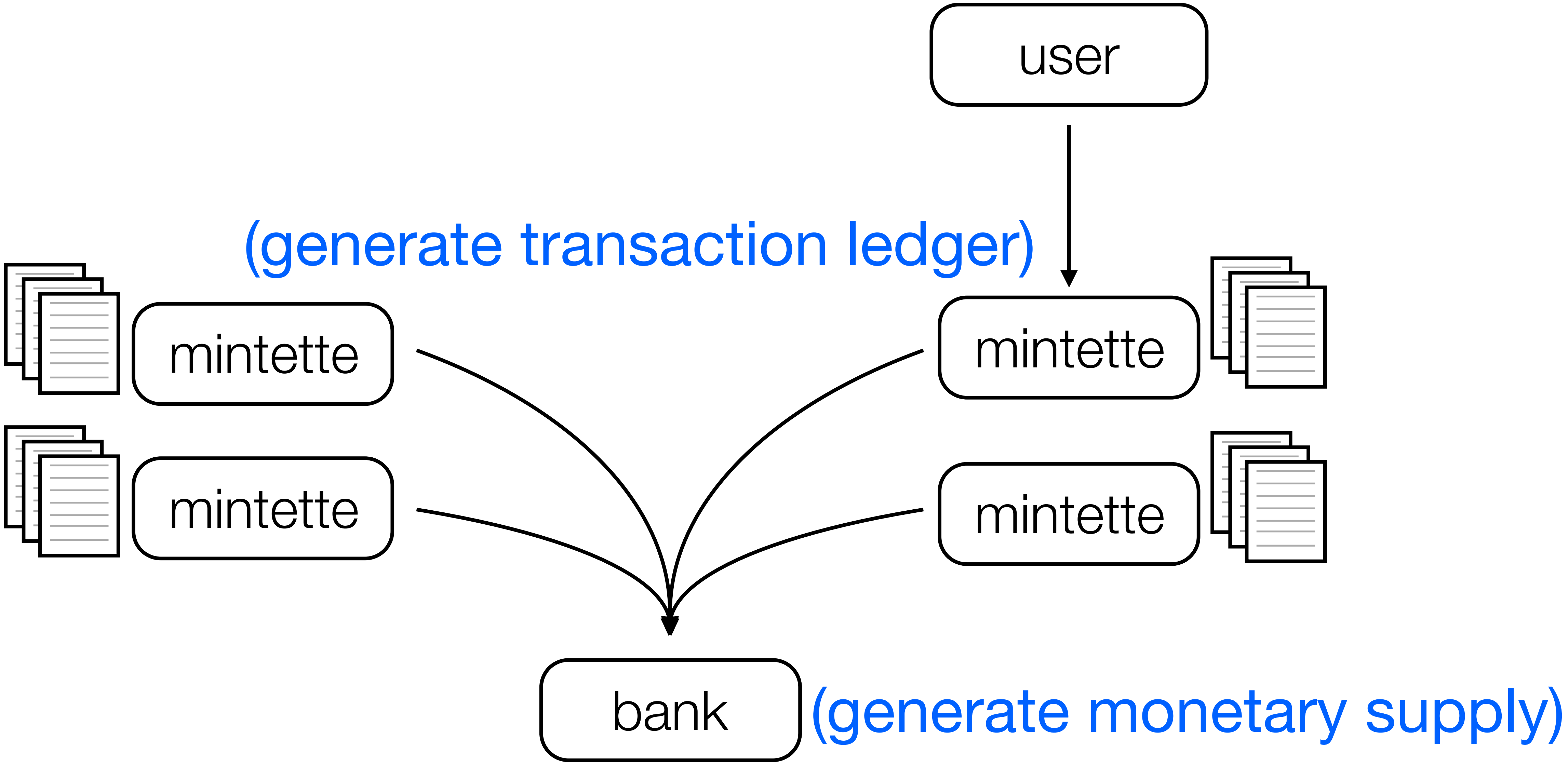
mintette

mintette

mintette

bank

(generate monetary supply)



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bank

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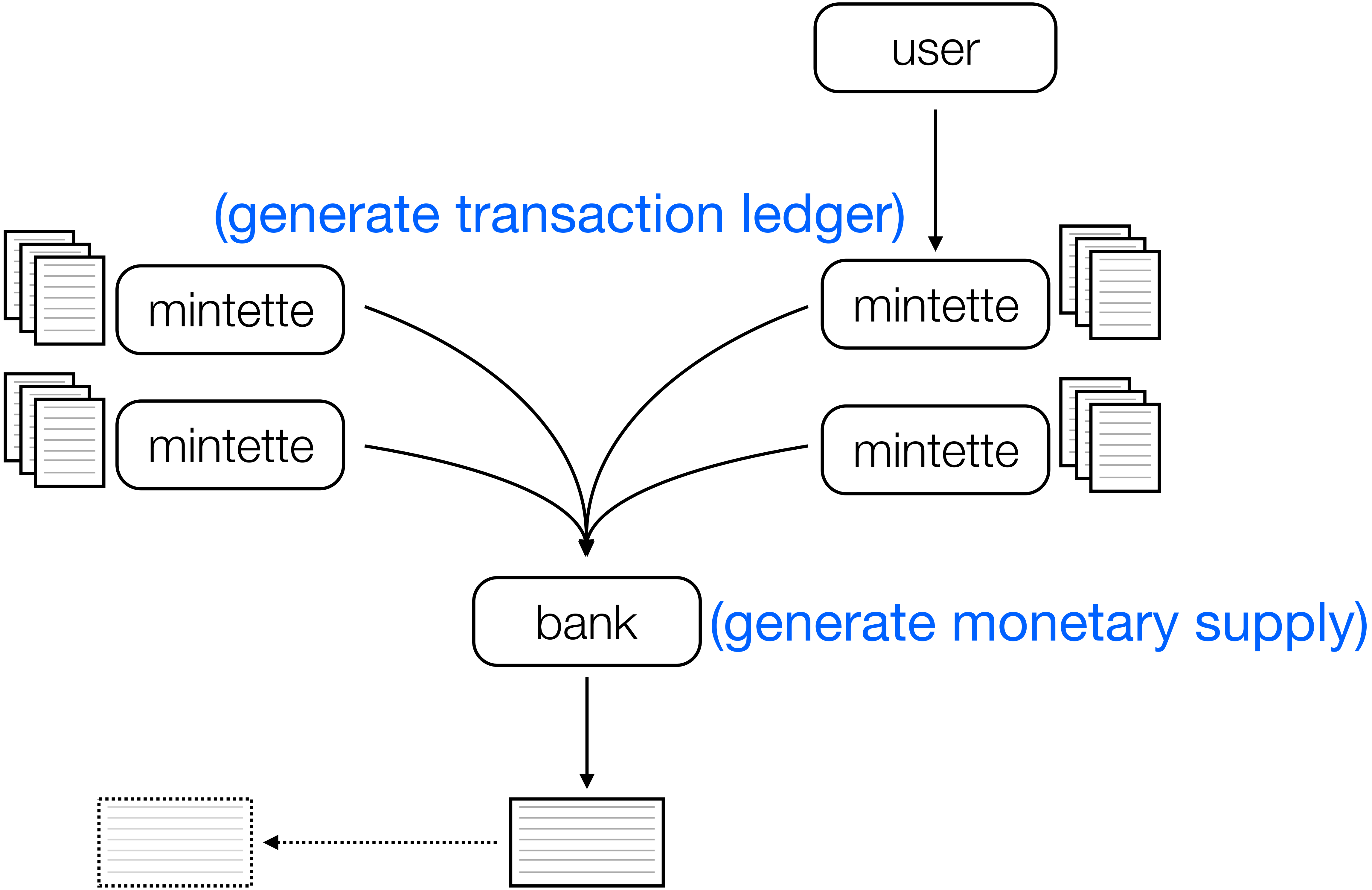

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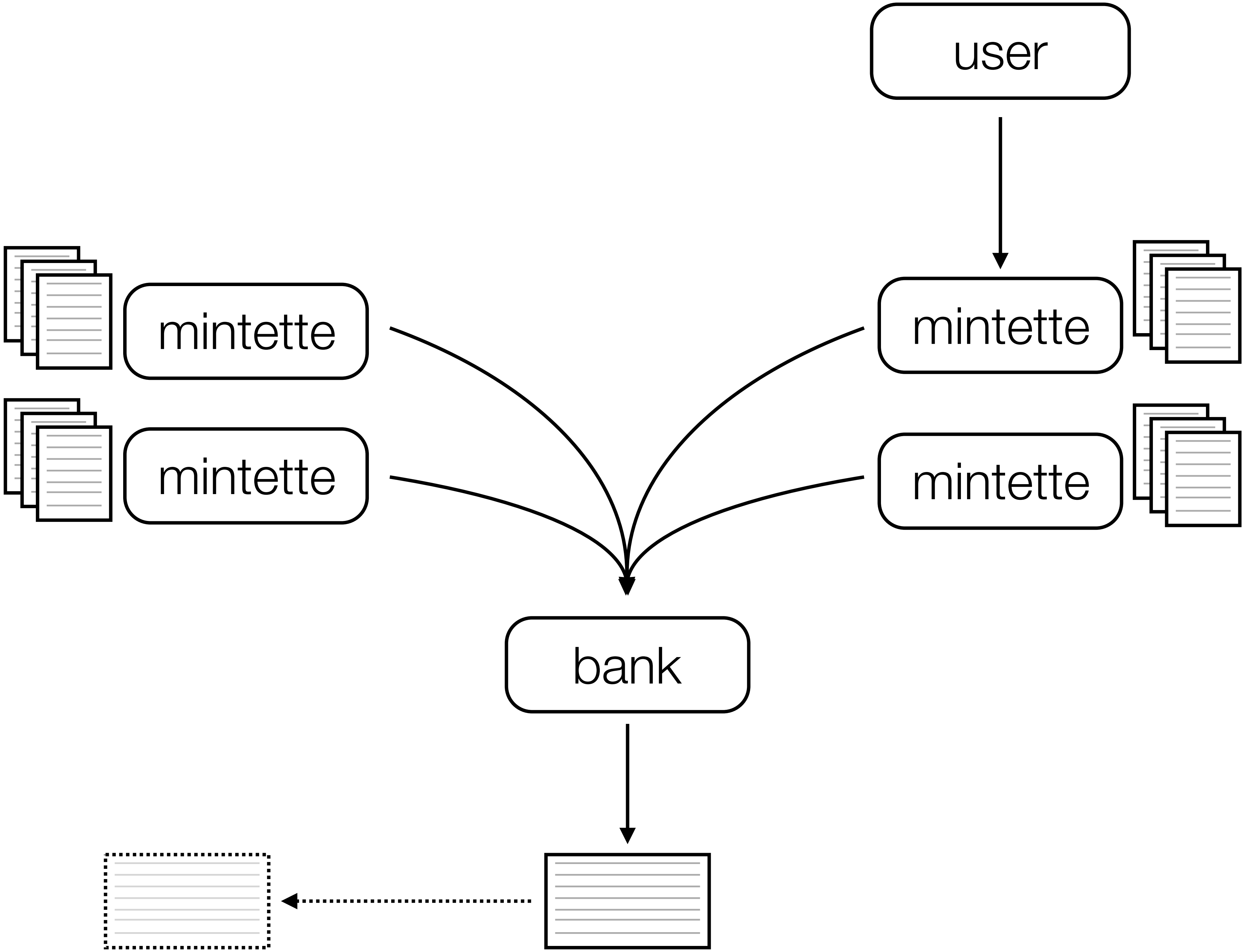
user
mintette
mintette
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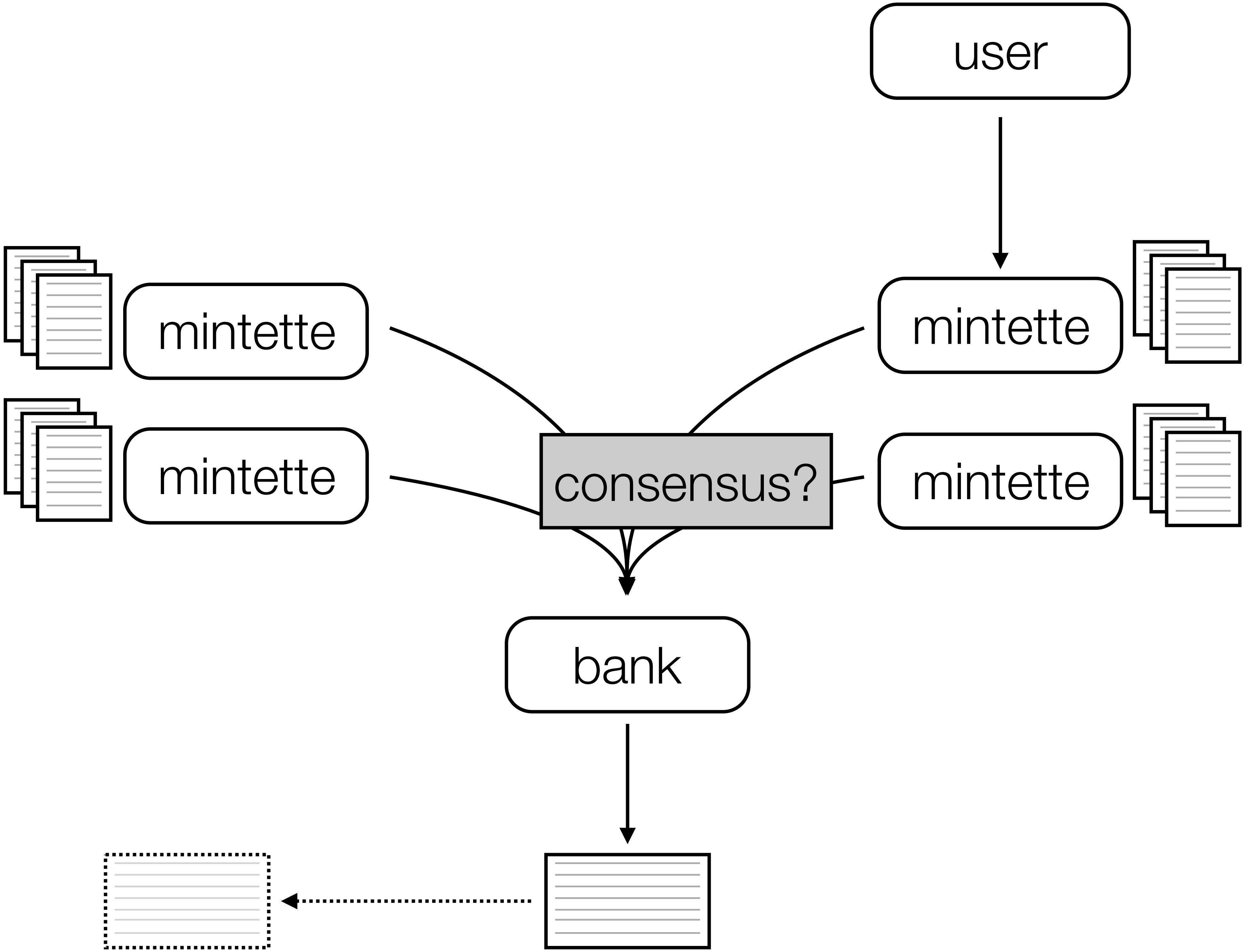
mintette
bank


user
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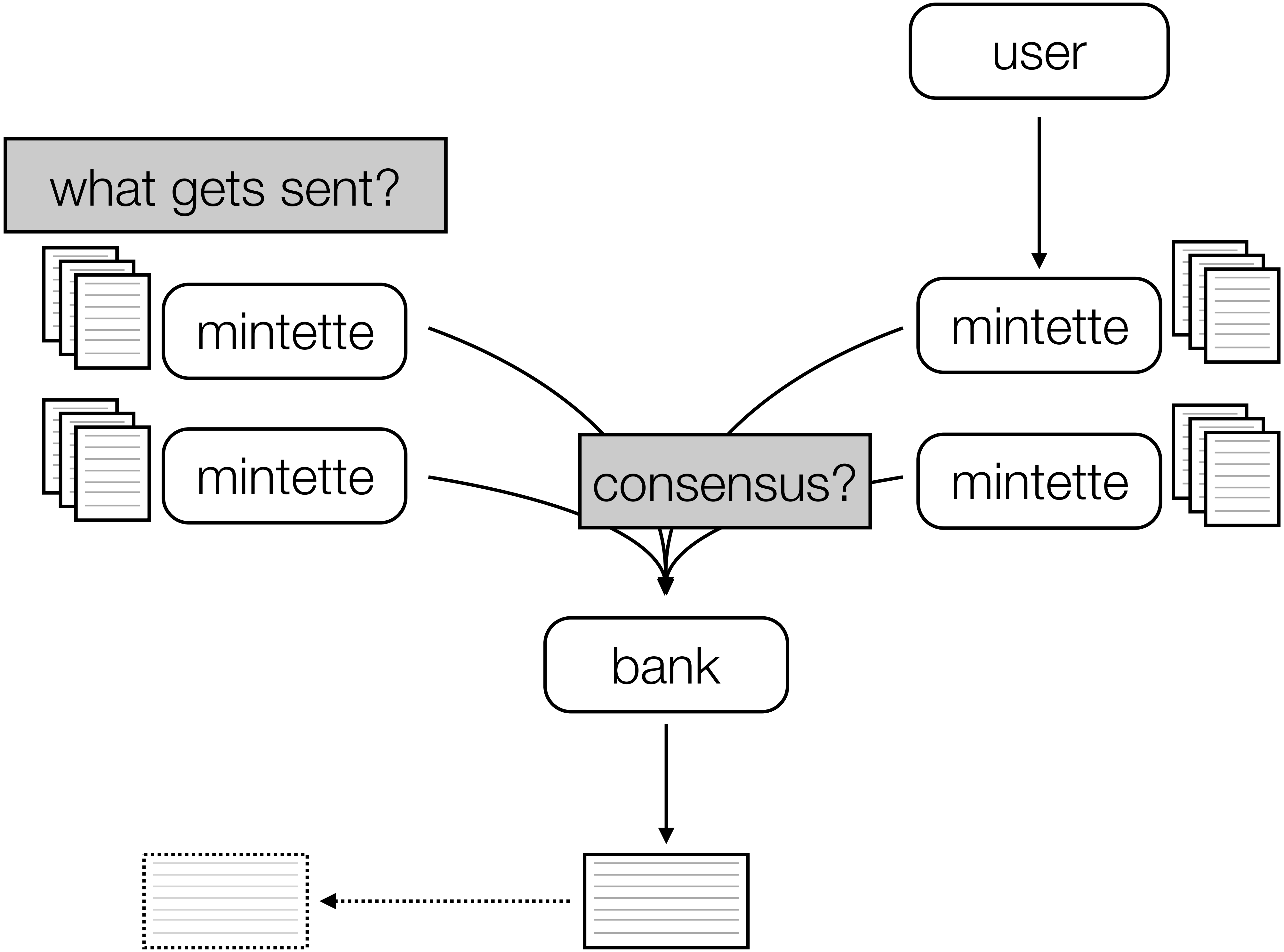
consensus?
bank


user
what gets sent?
mintette
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consensus?
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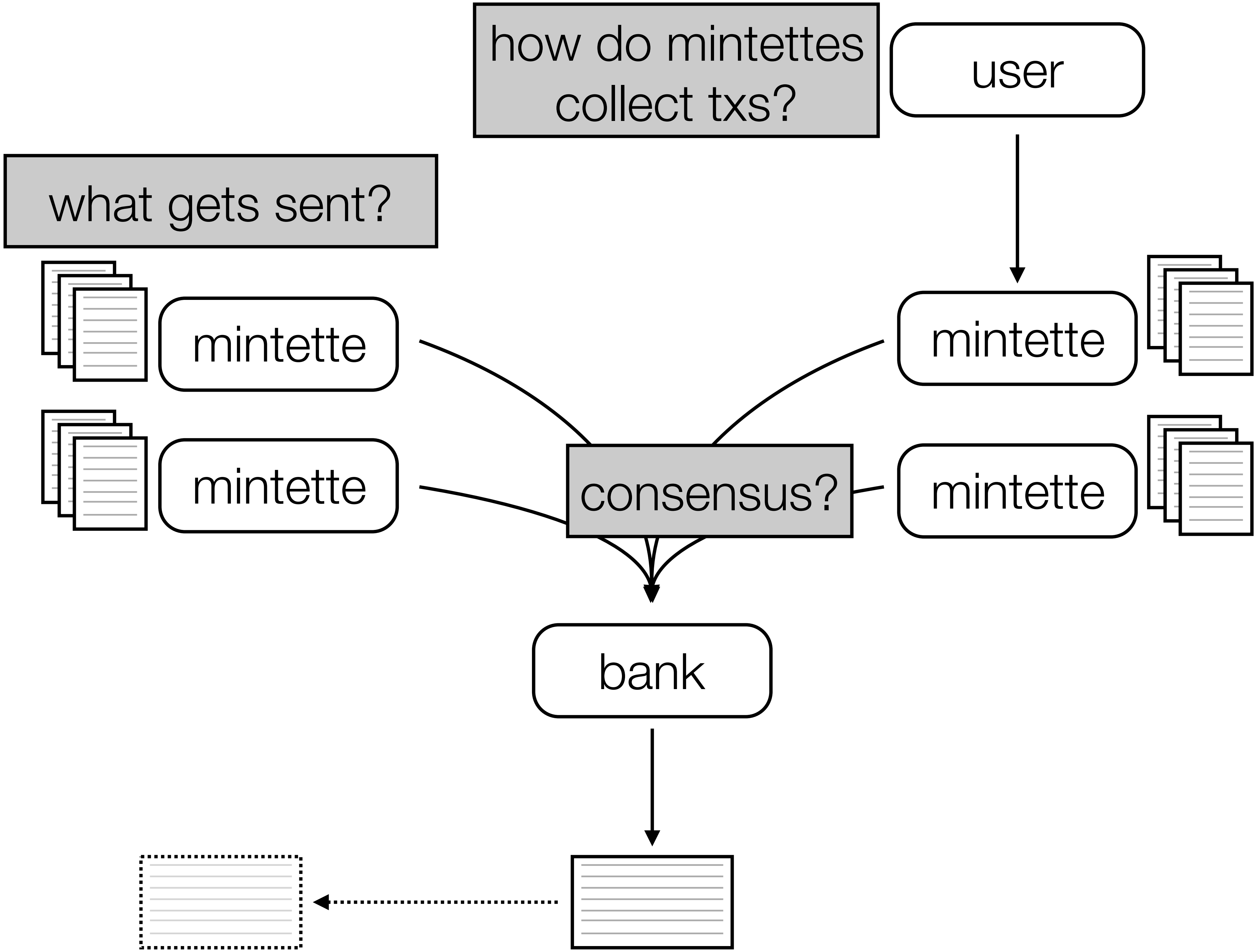

how do mintettes collect txs?

user

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mintette

mintette

mintette

consensus?

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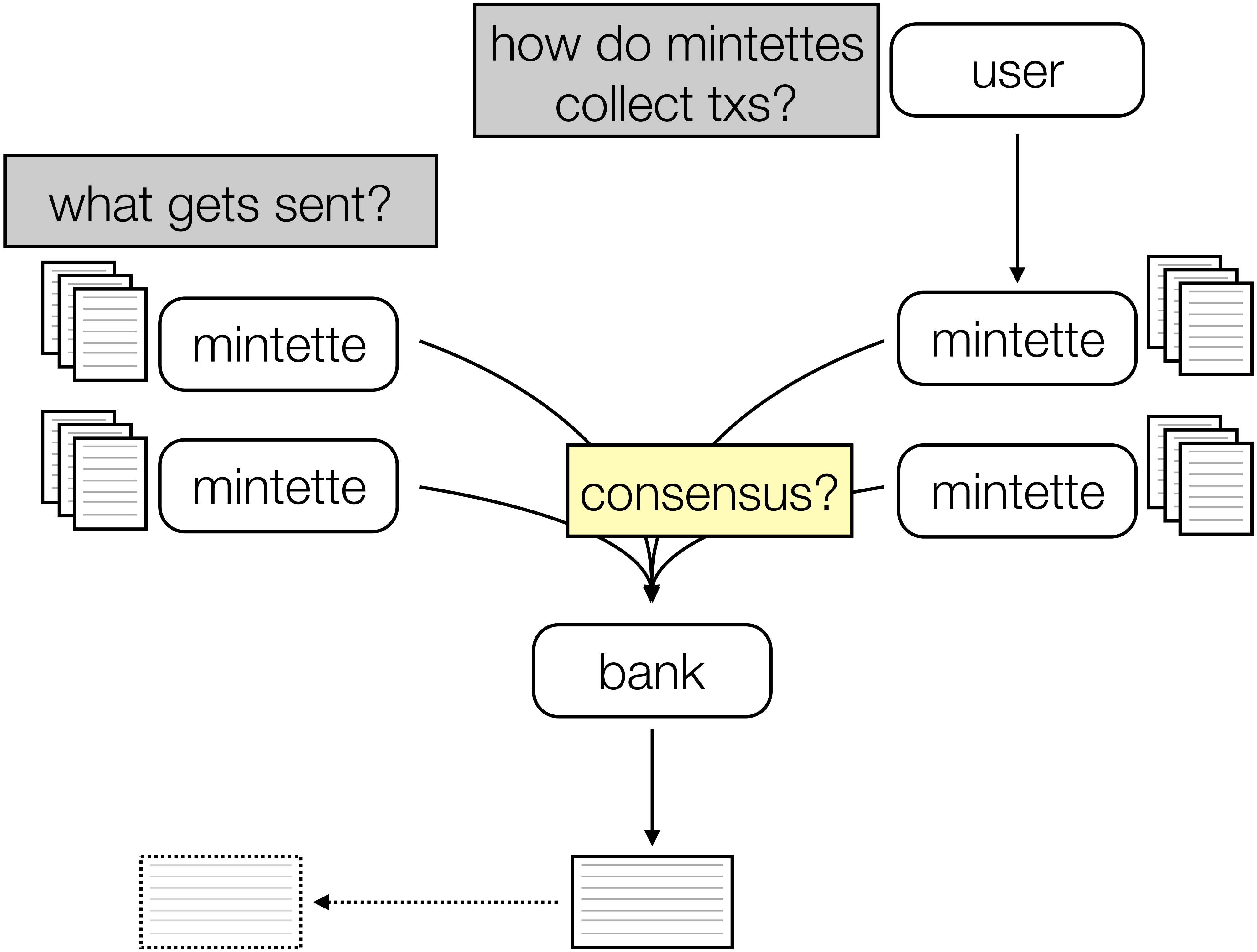
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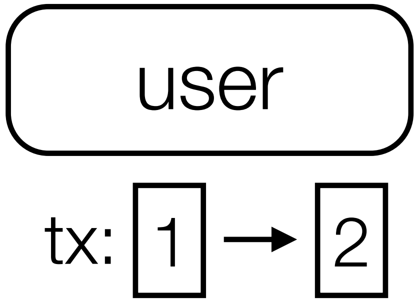
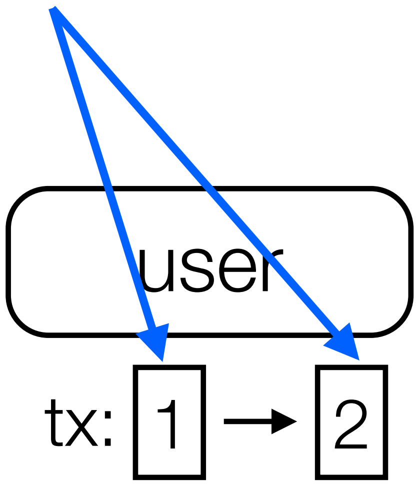


consensus

each address is **owned** by a set of mintettes



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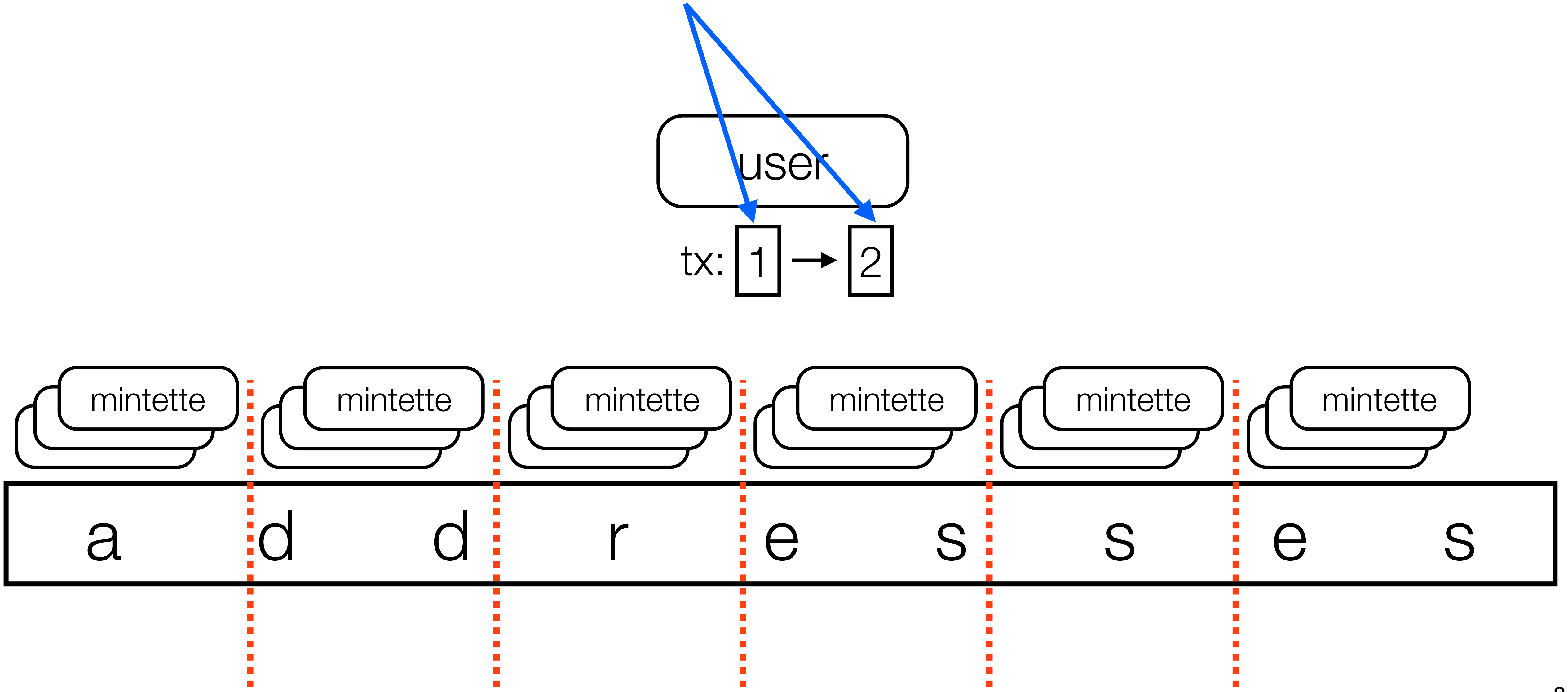
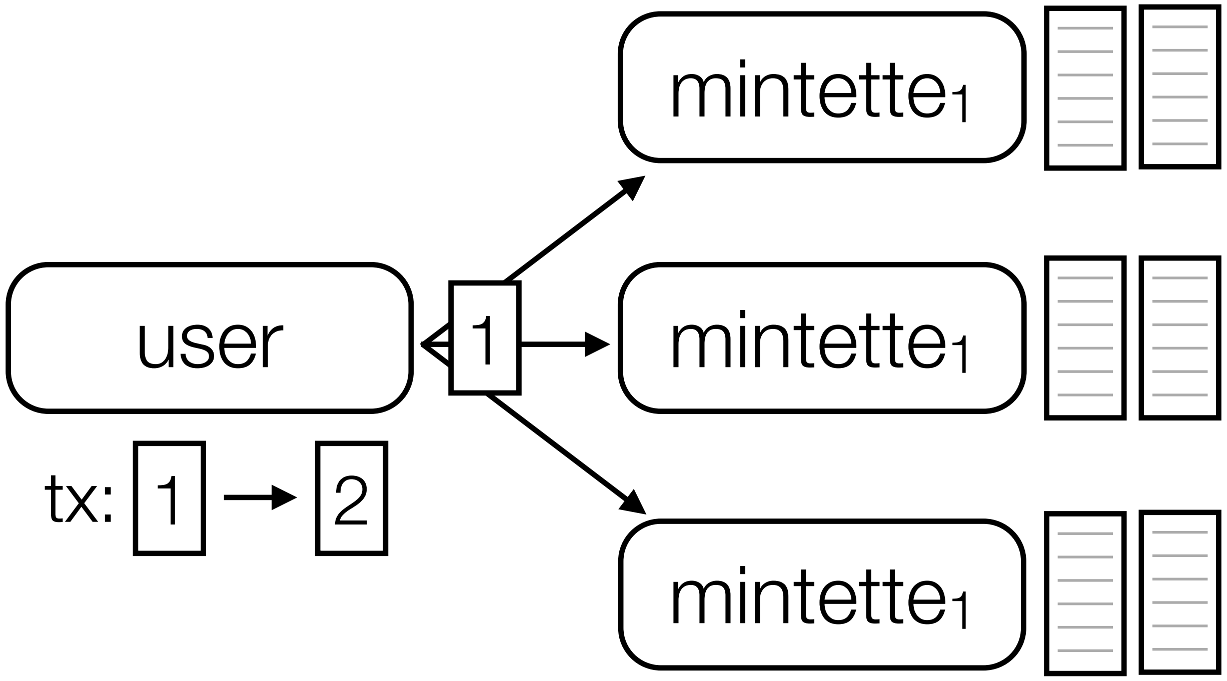
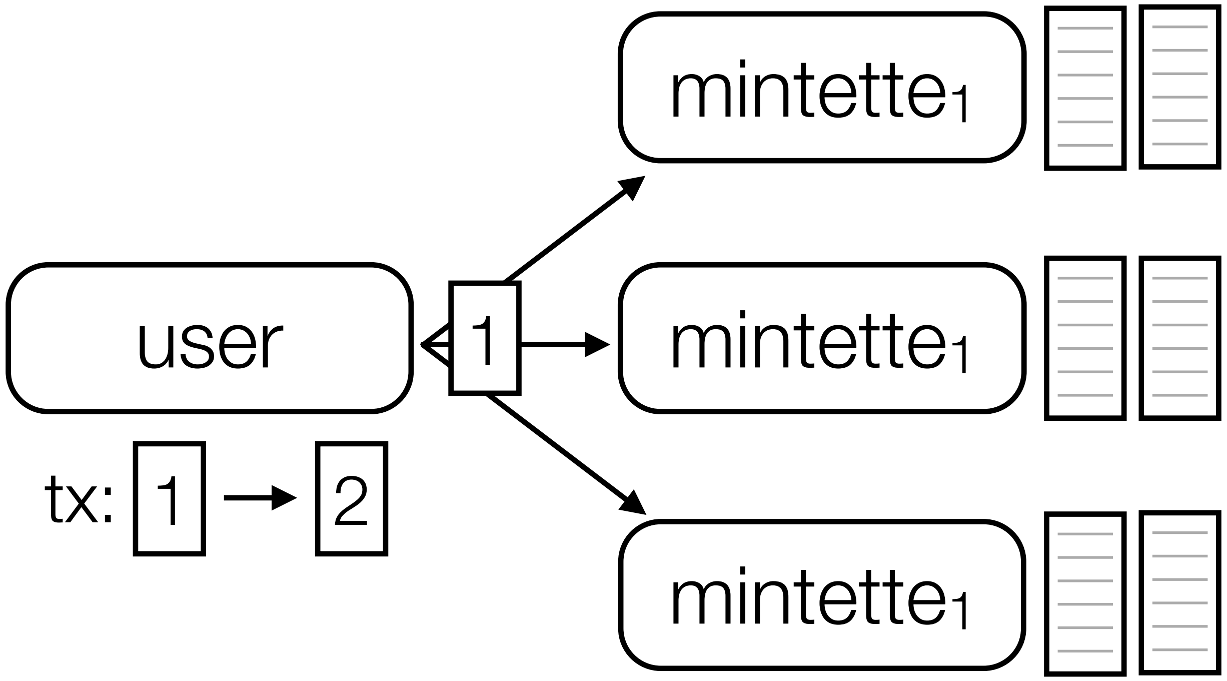


consensus



consensus

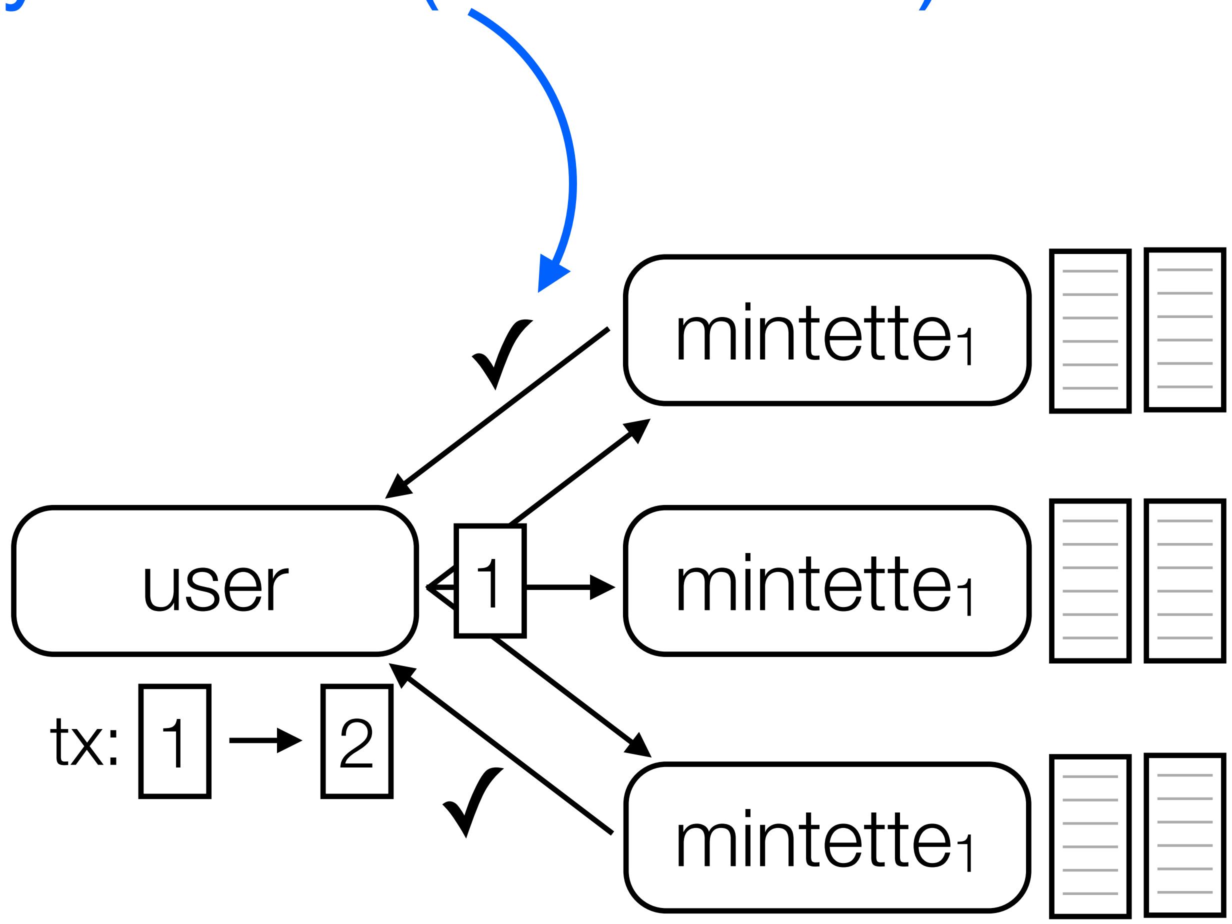
mintettes check for **double spending**…



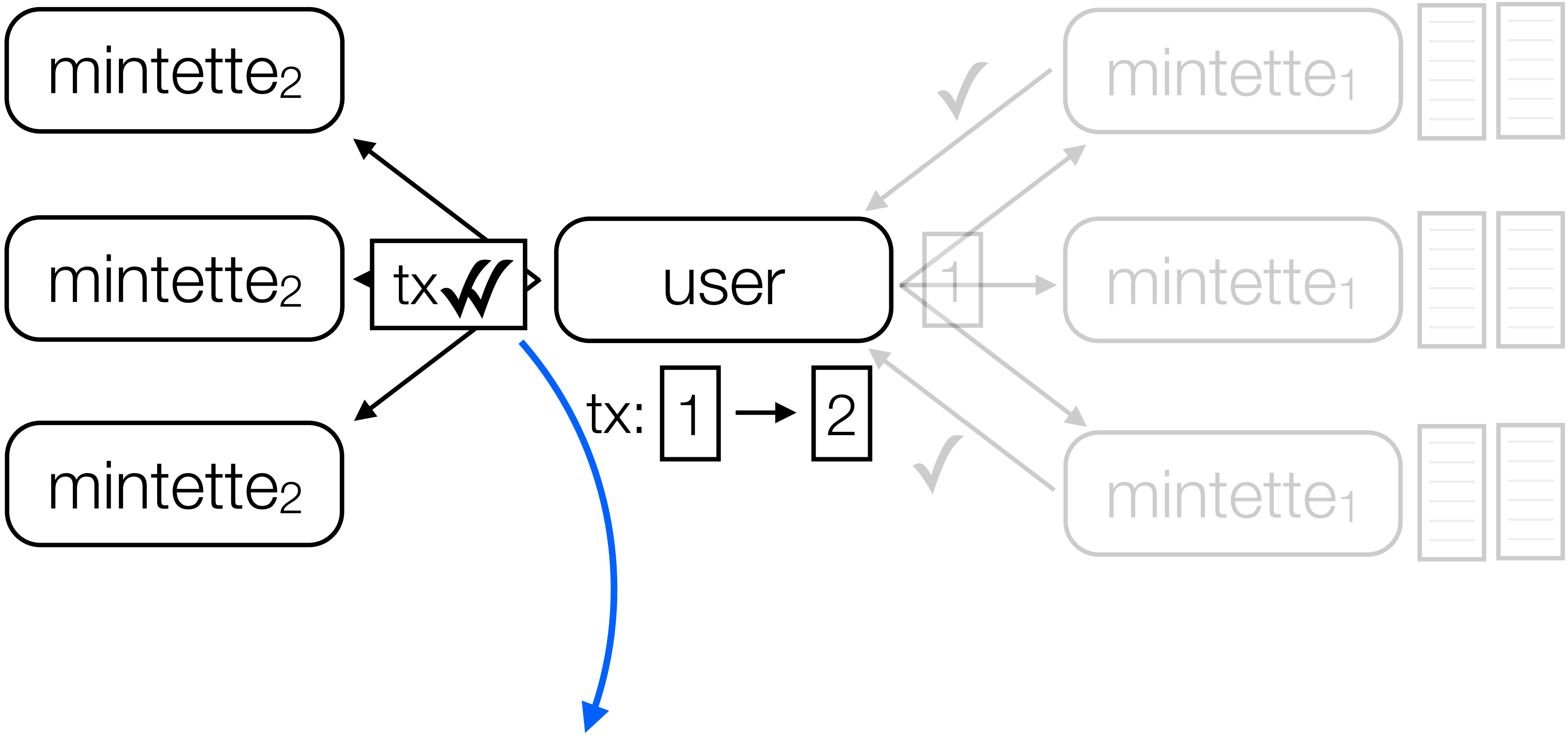
…using lists of **unspent transaction outputs** (utxo)

consensus

signed ‘yes’ vote (and head h)



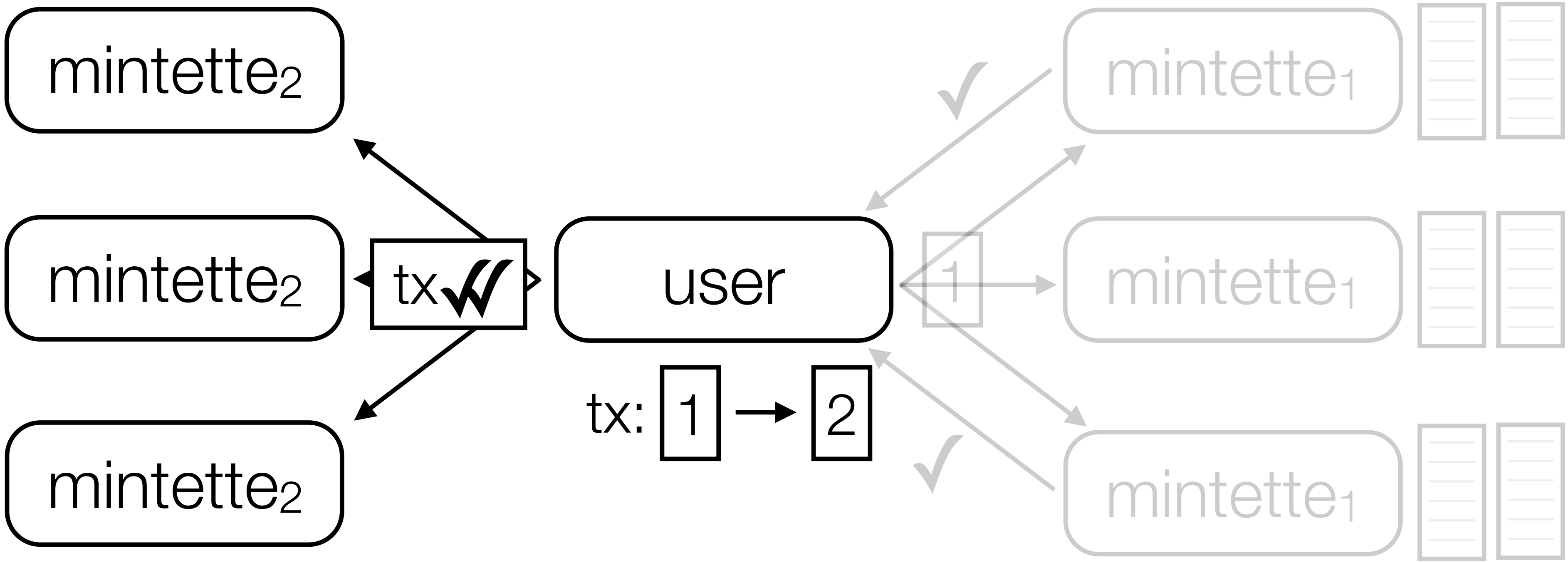
consensus



“bundle of evidence” contains ‘yes’ votes from **majority** of mintettes in shard

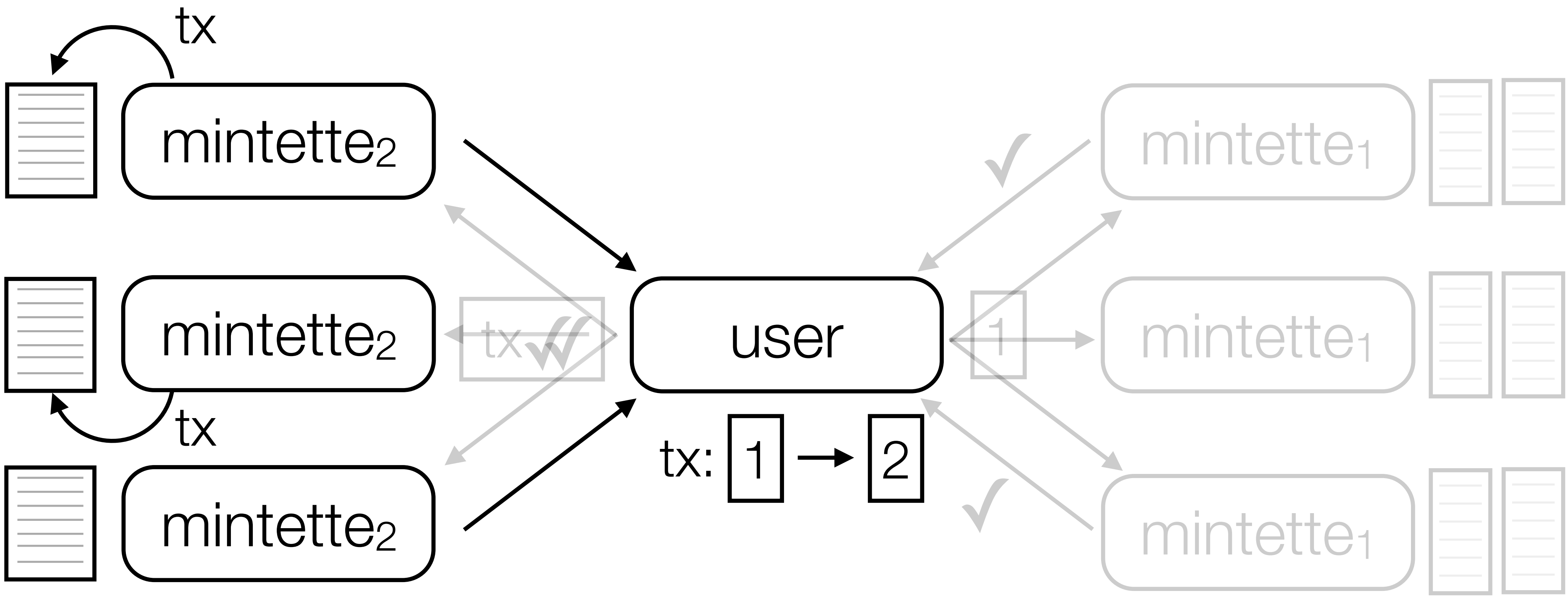
consensus

mintettes check validity of bundle by checking for signatures from authorized mintettes…



consensus

…and if satisfied they add transaction to be **committed** and send back **receipt**



consensus features

consensus features

simple (adaption of Two-Phase Commit)

consensus features

simple (adaption of Two-Phase Commit)

scalable!

consensus features

simple (adaption of Two-Phase Commit)

scalable!

T = set of txs generated per second

Q = # mintettes per shard

M = # mintettes

consensus features

simple (adaption of Two-Phase Commit)

scalable!

T = set of txs generated per second

Q = # mintettes per shard

M = # mintettes

$$\text{comm. per mintette per sec} = \frac{\sum_{tx \in T} 2(m_{tx}+1)Q}{M}$$

consensus features

simple (adaption of Two-Phase Commit)

scalable!

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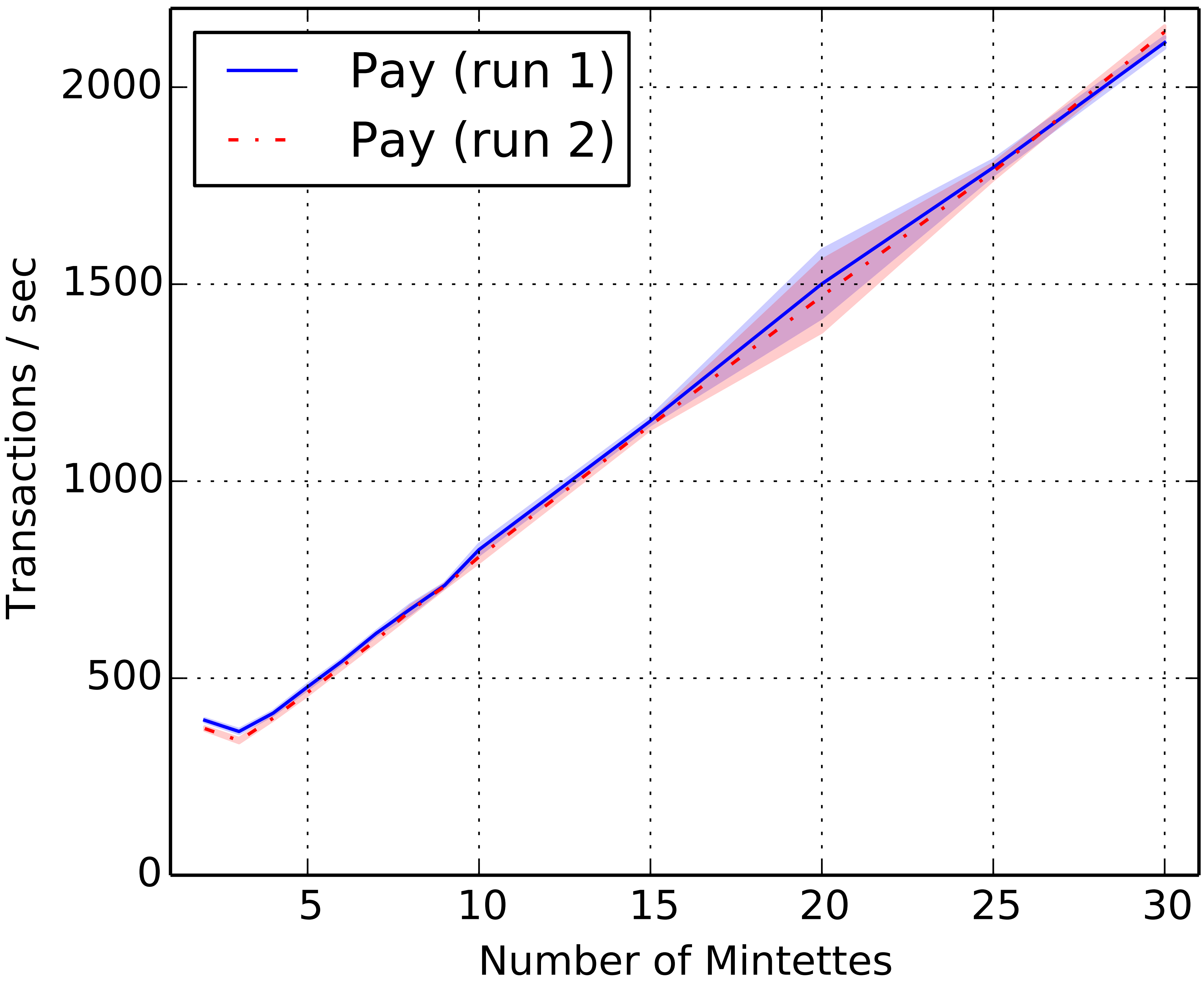
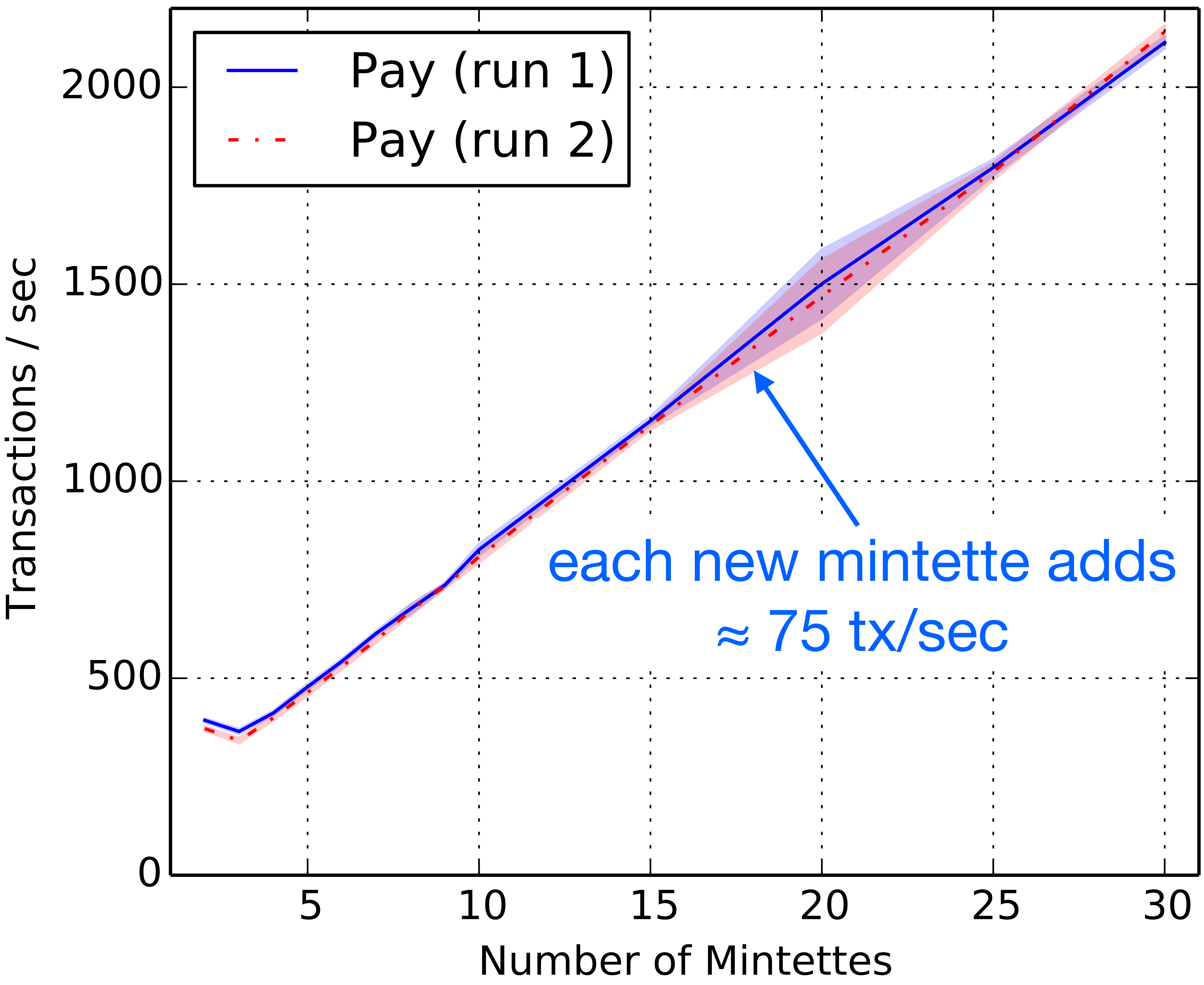
Q = # mintettes per shard

M = # mintettes

$$\text{comm. per mintette per sec} = \frac{\sum_{tx \in T} 2(m_{tx}+1)Q}{\boxed{M}}$$

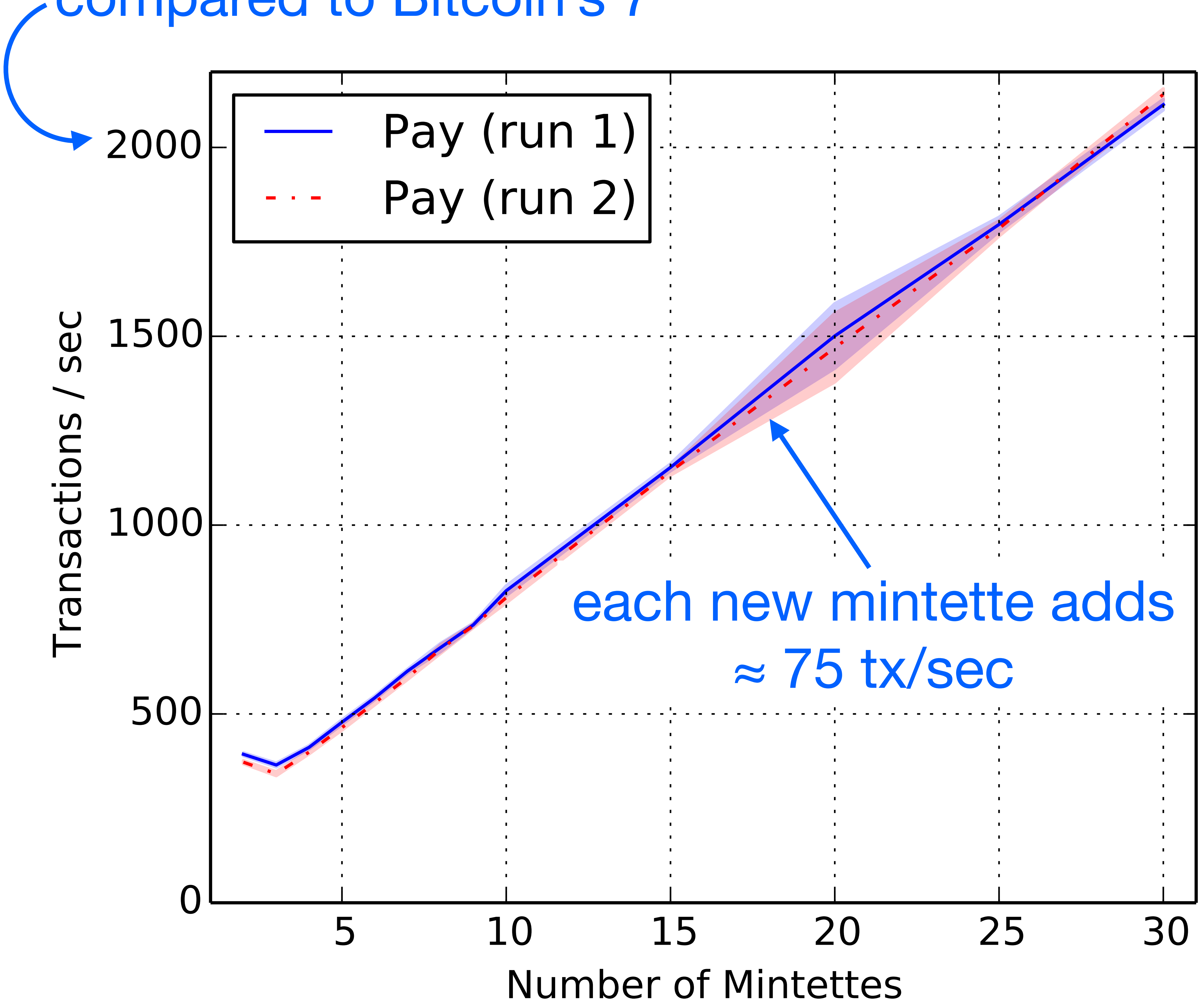
scales infinitely as more mintettes are added!


Pay (run 1)
Pay (run 2)
Transactions / sec
0
500
1000
1500
2000
Number of Mintettes
5
10
15
20
25
30



each new mintette adds ≈ 75 tx/sec

compared to Bitcoin's 7



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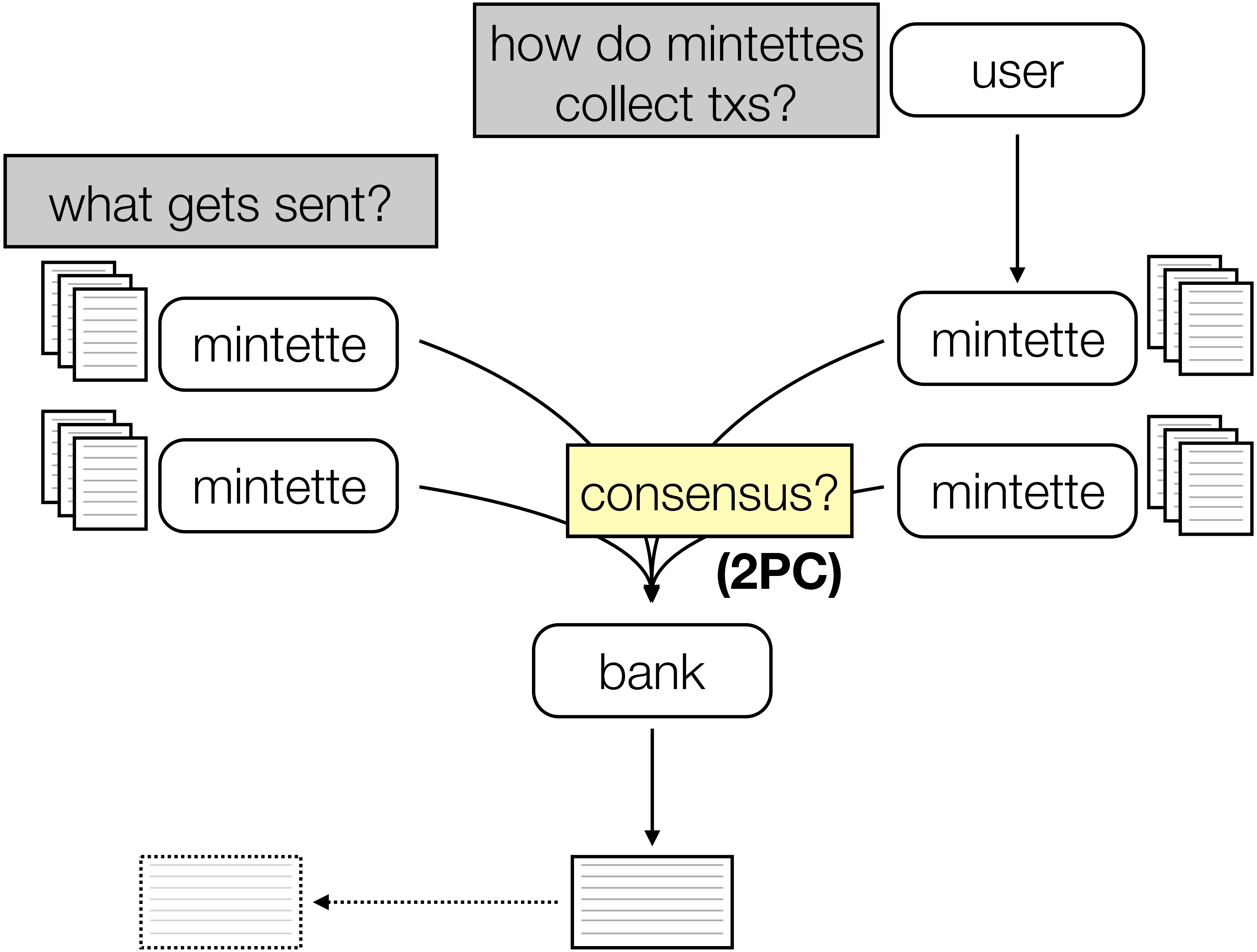
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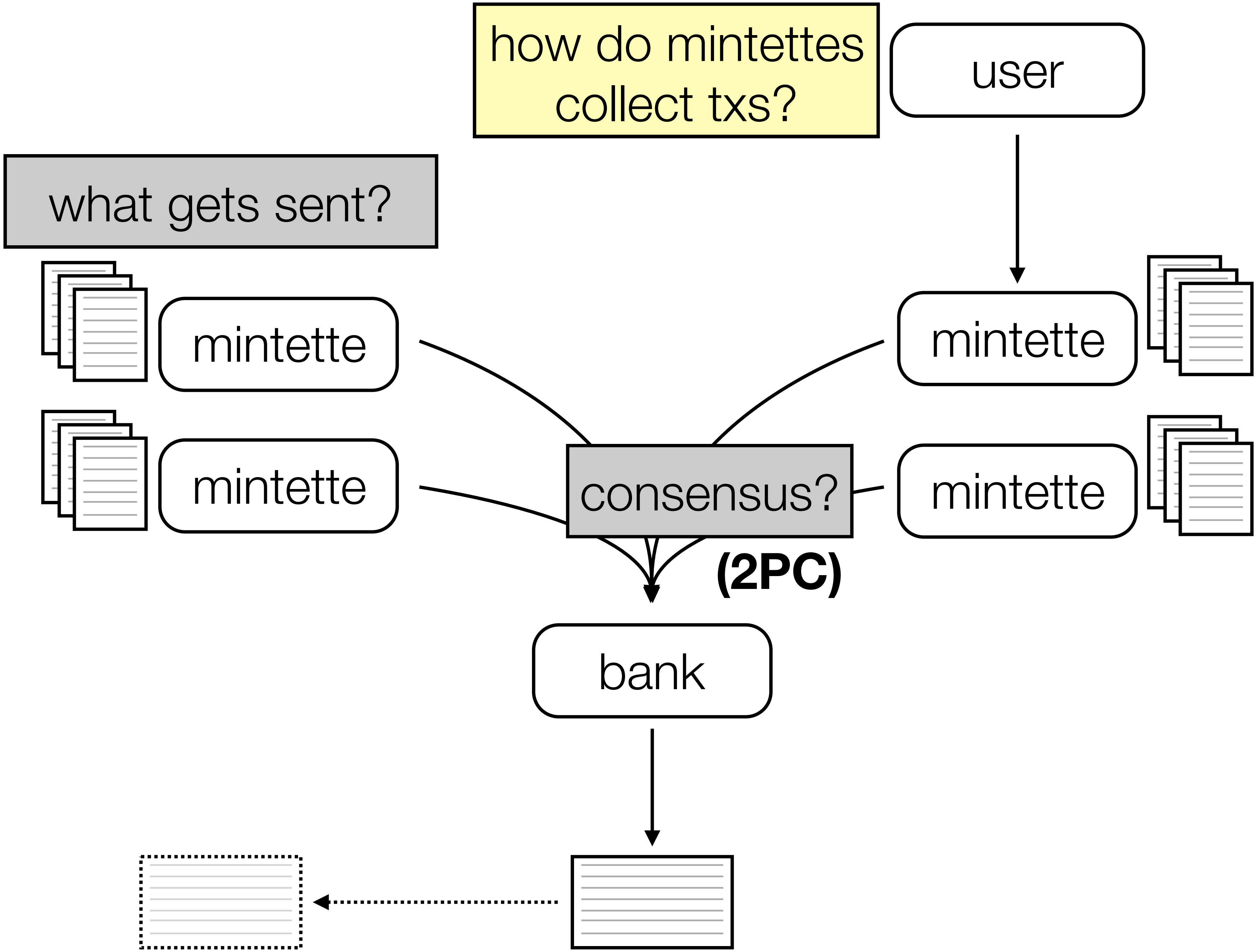
mintette
mintette
consensus?
(2PC)
bank

(contacted based on shard)

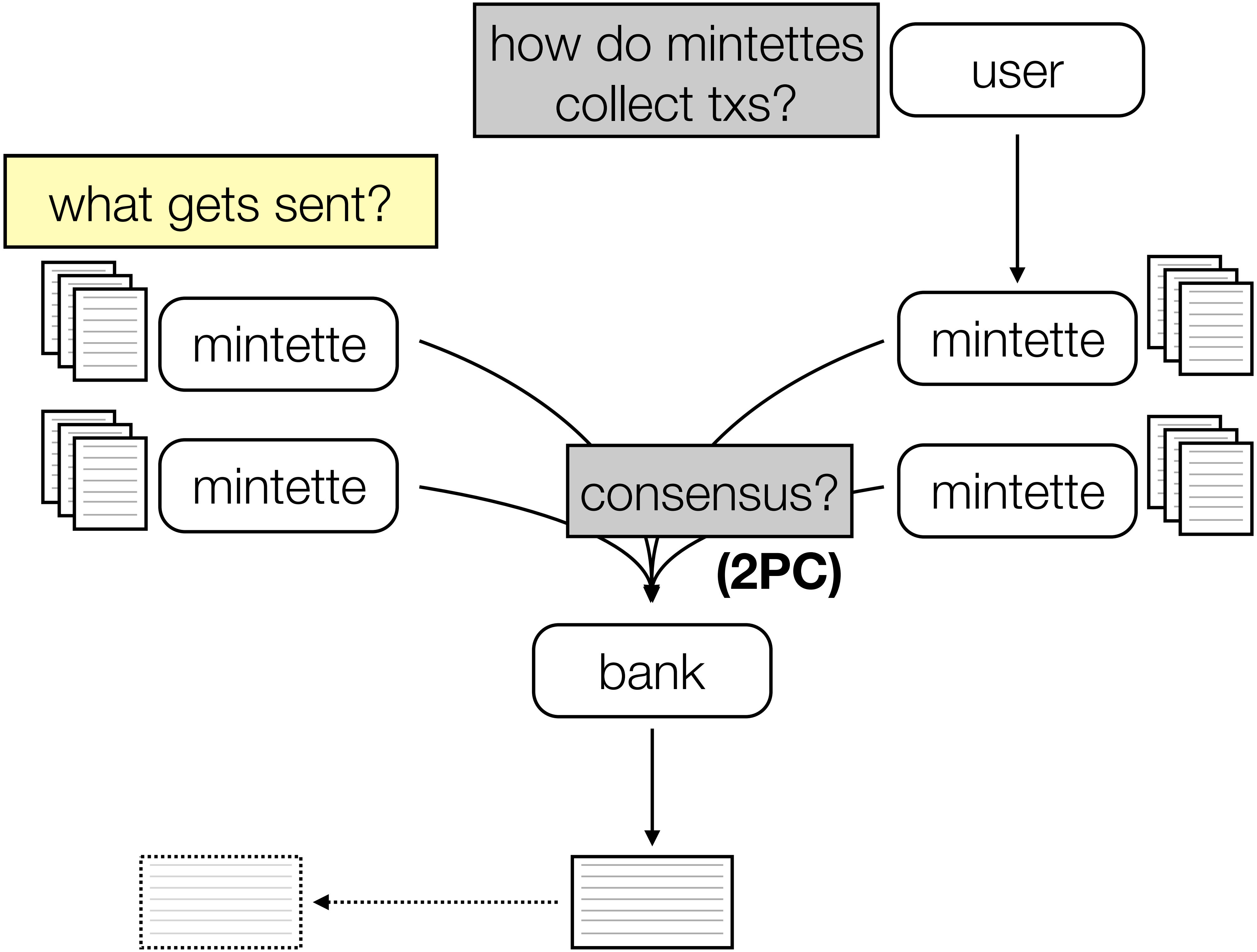

how do mintettes collect txs?

what gets sent?

consensus?

(2PC)

(contacted based on shard)



how do mintettes collect txs?

what gets sent?

consensus?

(2PC)

security properties

no double spending (only “good” transactions get included)

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(if honest majority)

security properties

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non-repudiation (mintettes are held to their promises)

security properties

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✓ non-repudiation (mintettes are held to their promises)

(because mintettes provide receipt upon committing transaction)

security properties

✓ no double spending (only “good” transactions get included)

✓ non-repudiation (mintettes are held to their promises)

auditability (mintettes can’t cheat without detection)

mintette logs

borrow ideas from Certificate Transparency to log actions

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mintettes create log entry every time they:

-act as mintette in first phase (Query)

-act as mintette in second phase (Commit)

-publish head of hash chain (CloseEpoch)

rolling hash chain of log acts as commitment to actions

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mintettes cross-hash chains to provide evidence of activity

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rolling hash chain of log acts as commitment to actions

mintettes cross-hash chains to provide evidence of activity

send logs to bank at end of every period

security properties

✓ no double spending (only “good” transactions get included)

✓ non-repudiation (mintettes are held to their promises)

auditability (mintettes can’t cheat without detection)

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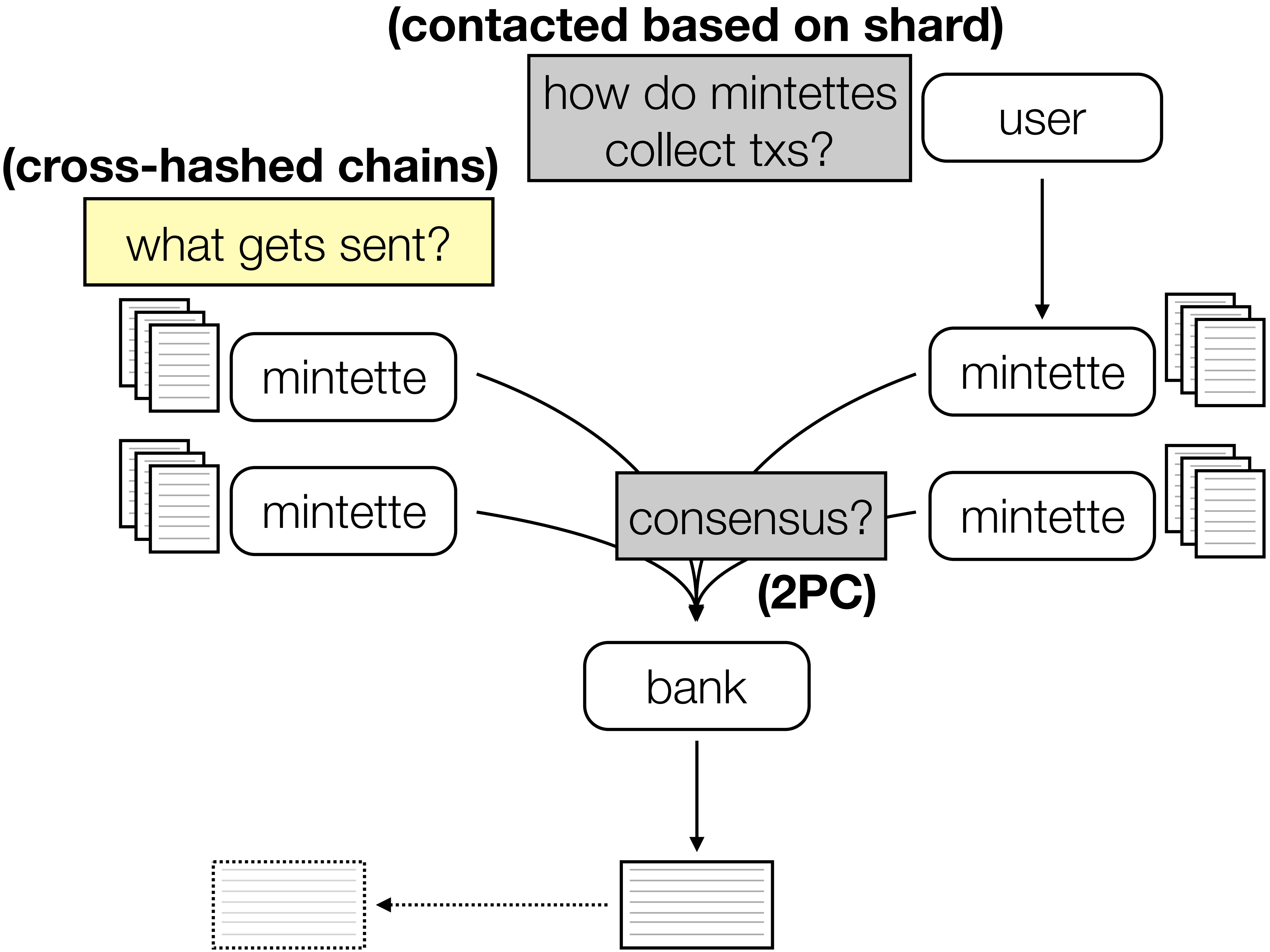


(contacted based on shard)

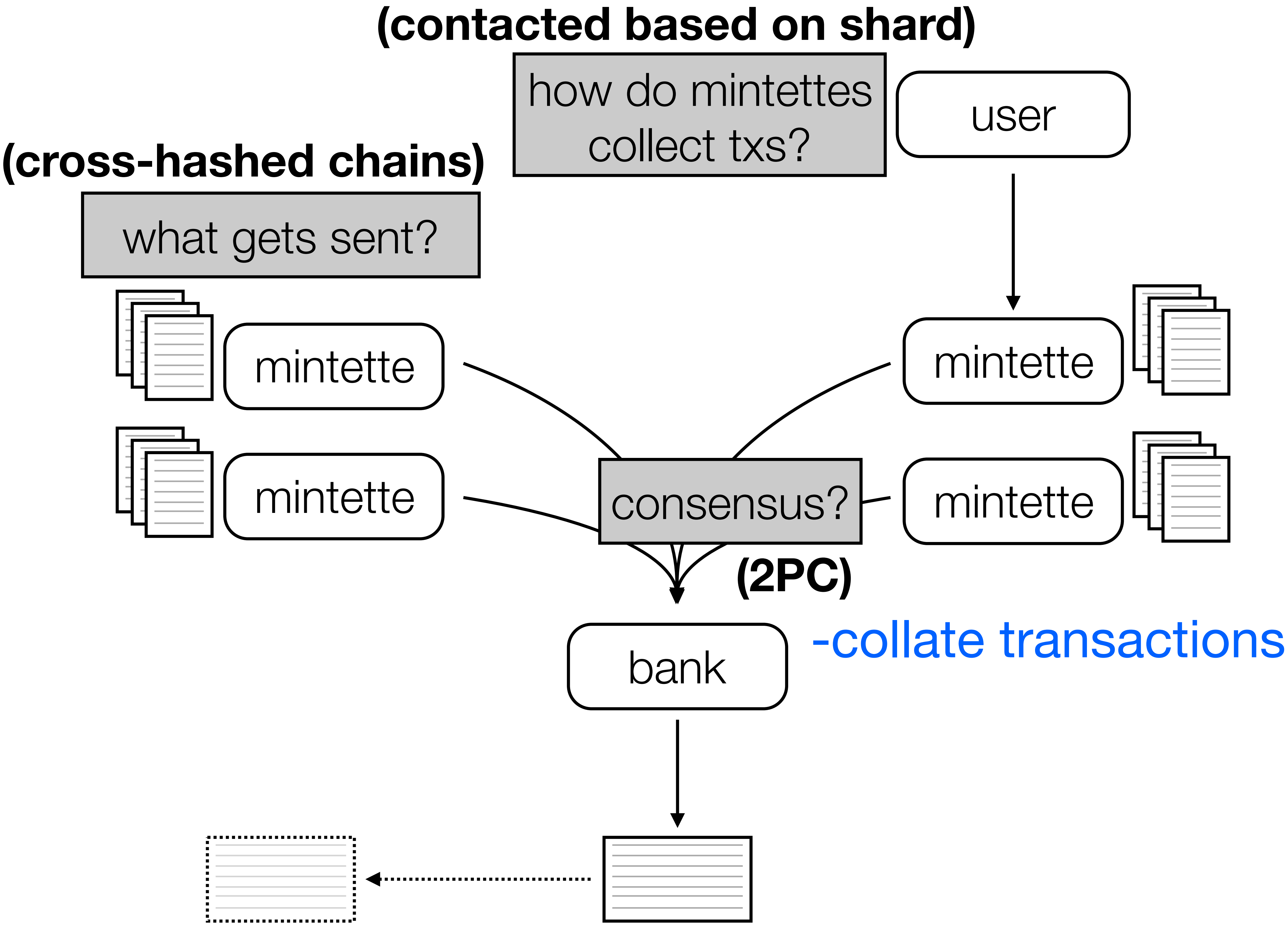
how do mintettes collect txs?

(cross-hashed chains)

what gets sent?

consensus?

(2PC)



(contacted based on shard)

how do mintettes collect txs?

user

(cross-hashed chains)

what gets sent?

mintette

mintette

mintette

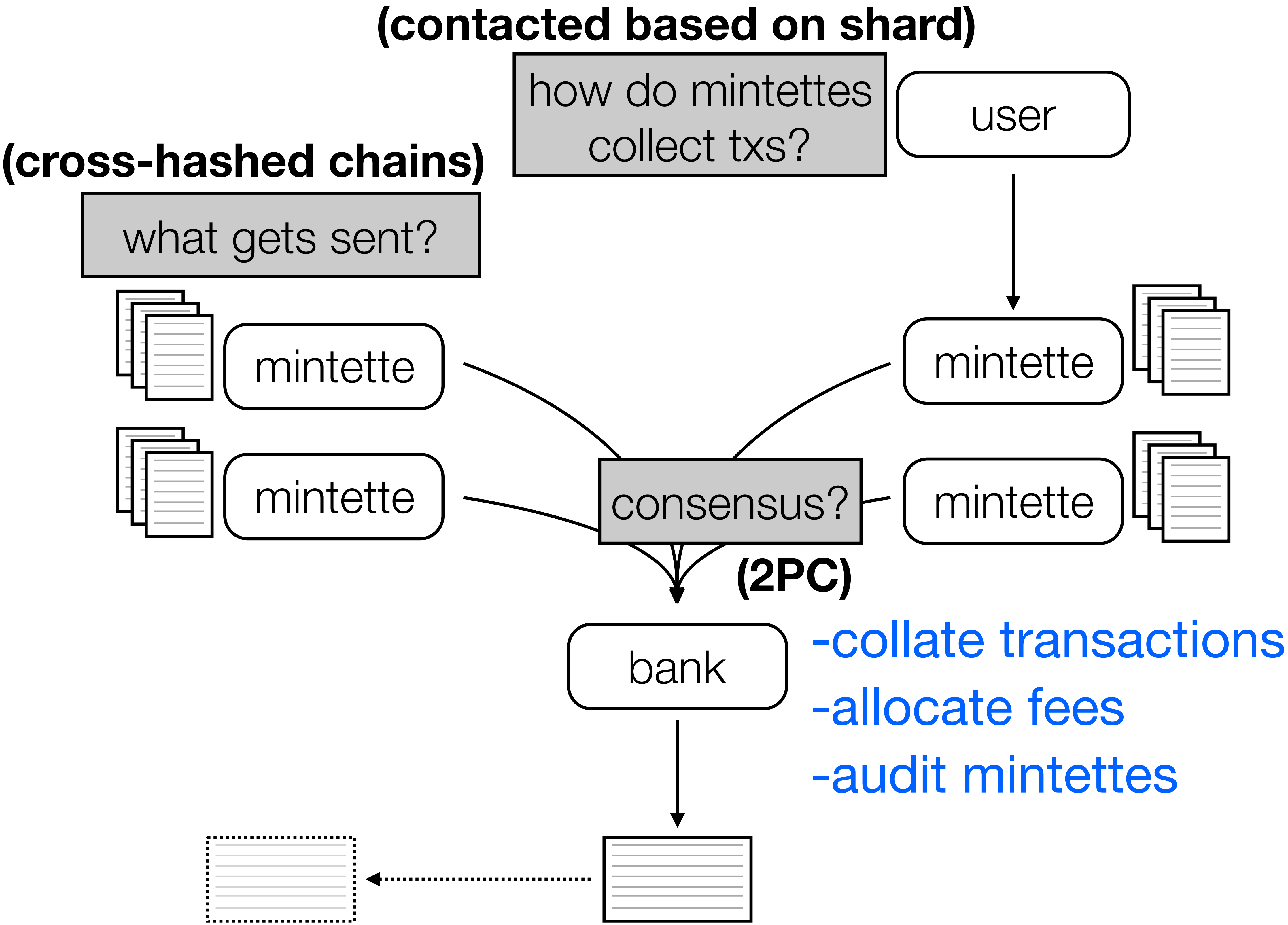
mintette

consensus?

(2PC)

bank

-collate transactions



(contacted based on shard)

how do mintettes collect txs?

user

(cross-hashed chains)

what gets sent?

mintette

mintette

mintette

mintette

consensus?

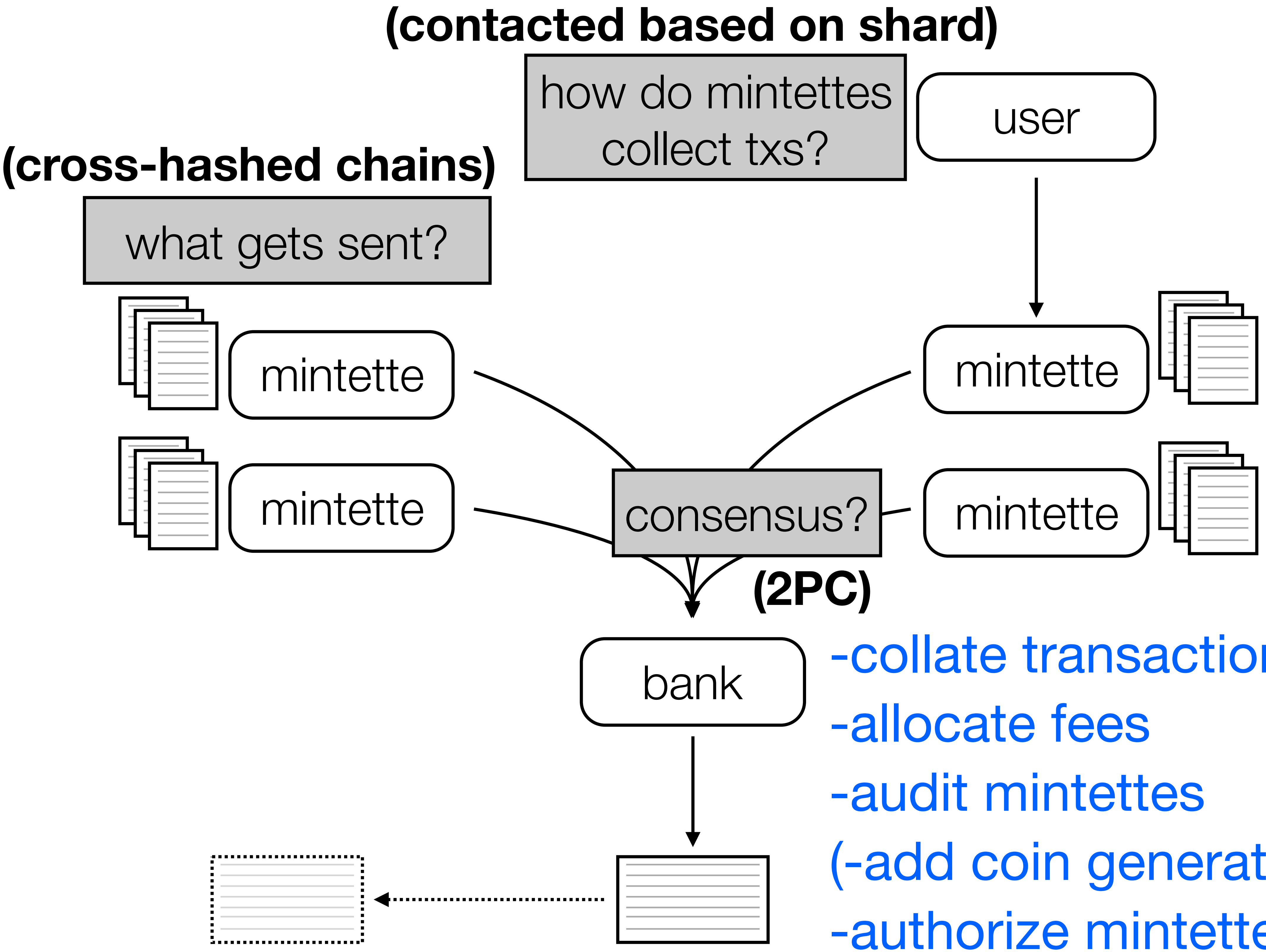
(2PC)

bank

-collate transactions

-allocate fees

-audit mintettes



(contacted based on shard)

how do mintettes collect txs?

user

(cross-hashed chains)

what gets sent?

mintette

mintette

mintette

mintette

consensus?

(2PC)

bank

-collate transactions

-allocate fees

-audit mintettes

(-add coin generation)

-authorize mintettes

		RSCoin	
monetary supply	decentral	central	central
ledger	decentral	distribute	central
transparent?	y	y (or n)	n
pseudonyms?	y	y (or n)	n
computation	high!	low	low

Thanks! Any questions?

		RSCoin	
monetary s			central
ledge			central
transparent?	y	y (or n)	n
pseudonyms?	y	y (or n)	n
computation	high!	low	low