Statechains:

Off-chain Transfer of UTXO Ownership

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What Statechains Achieve

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- Advantage over Lightning:

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- Advantage over Federated Sidechains:

  federation doesn’t have full control
- Unique limitation: can only move full UTXO amount

What Statechains Build On

- Schnorr signatures
- Adaptor signatures
- Eltoo
- Graftroot

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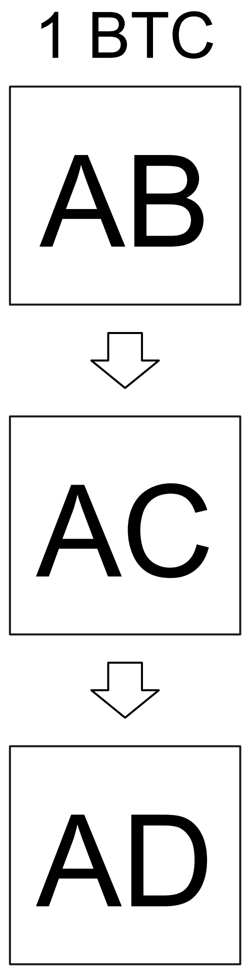
Works on any cryptocurrency that supports the above

High-level Overview



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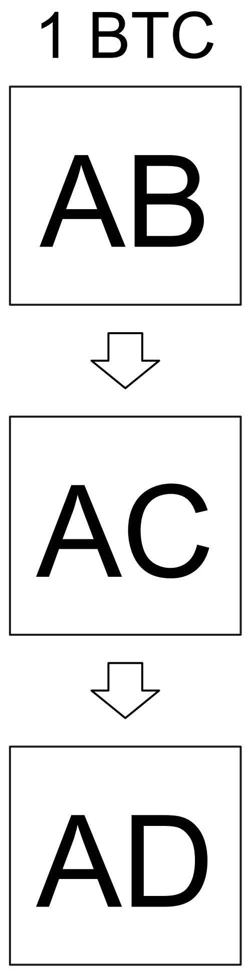
- Change UTXO ownership off-chain



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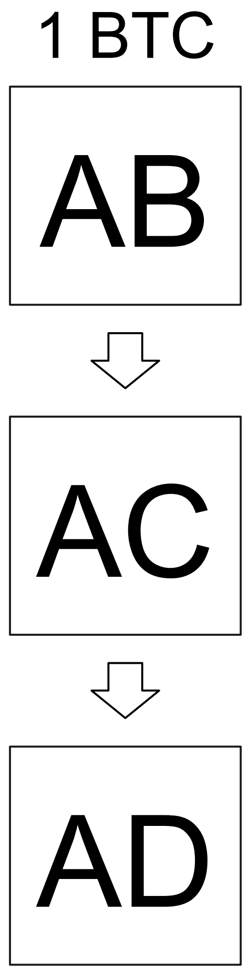

High-level Overview

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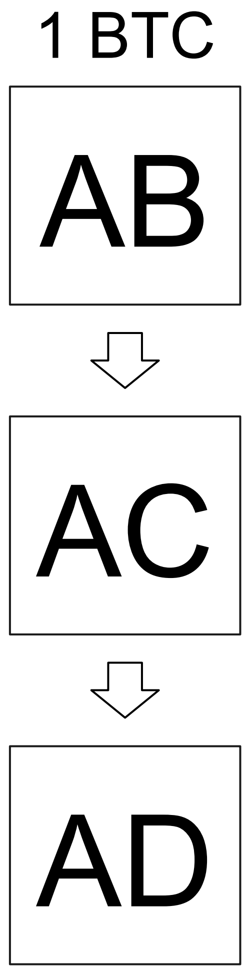

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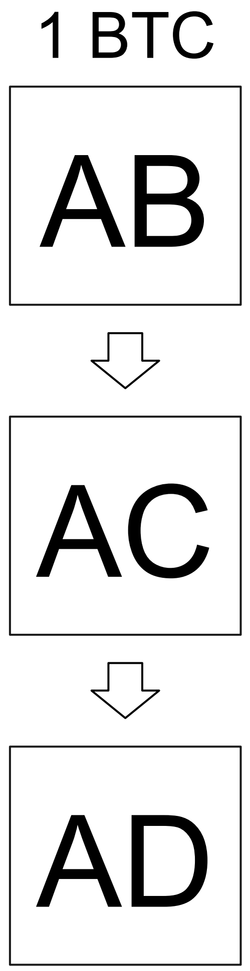

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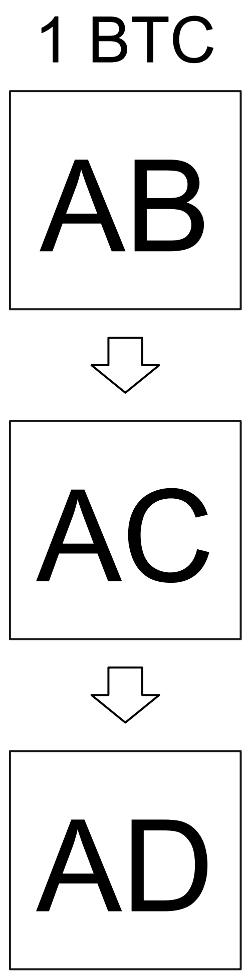
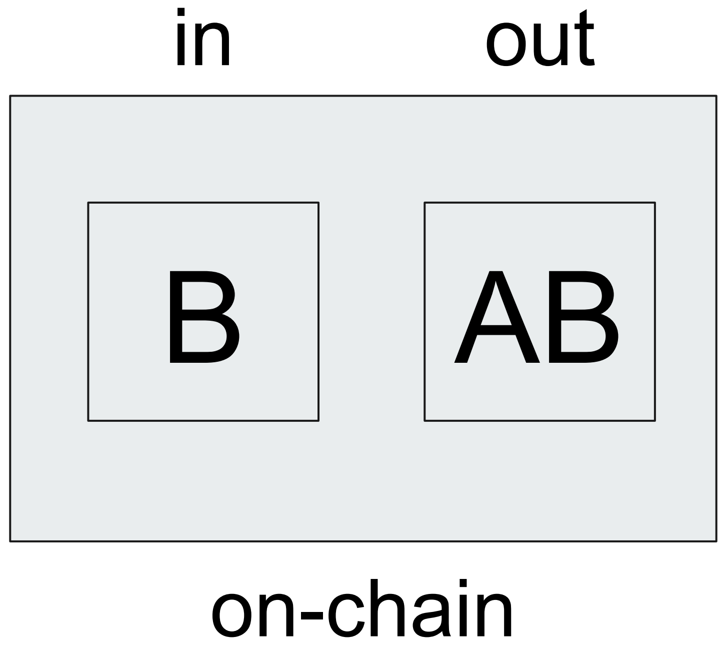
- A can collude with prior owners (B, C)
- Collusion/cheating always provable



Bob locks up 1 BTC with Alice...



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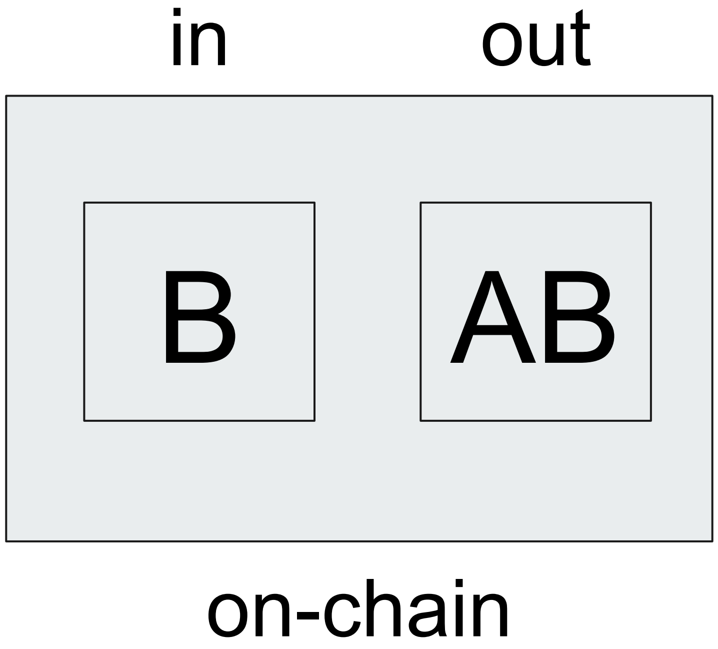
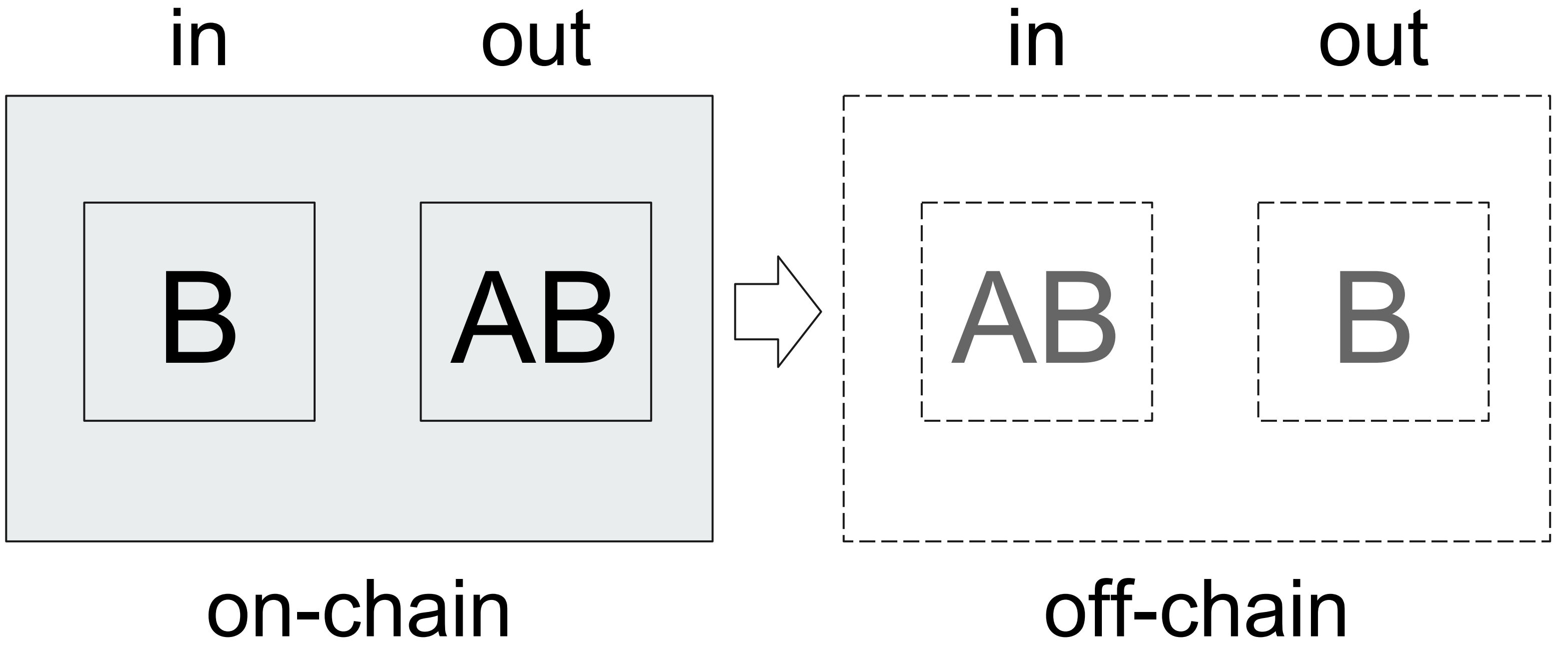
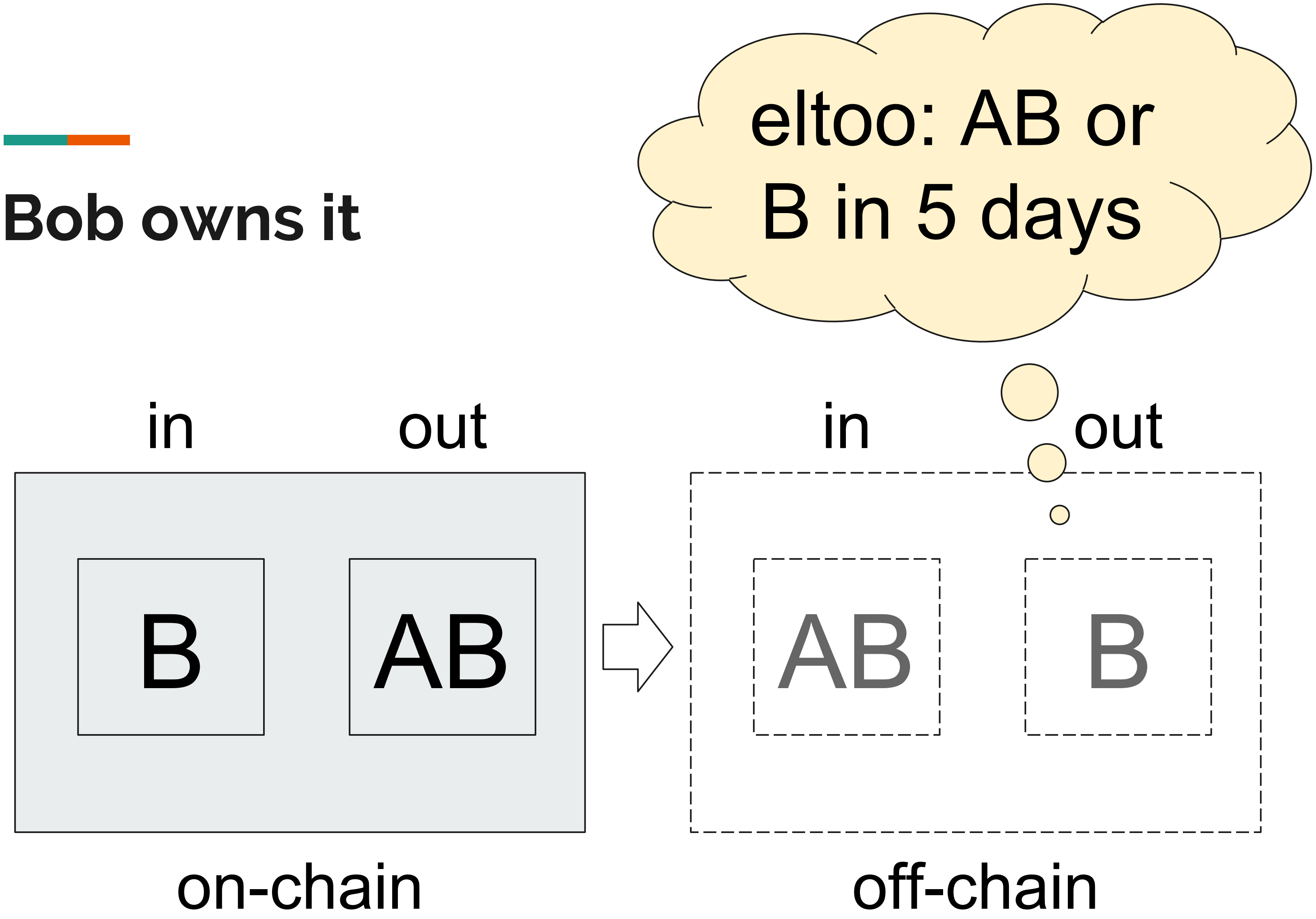


...but who owns it?

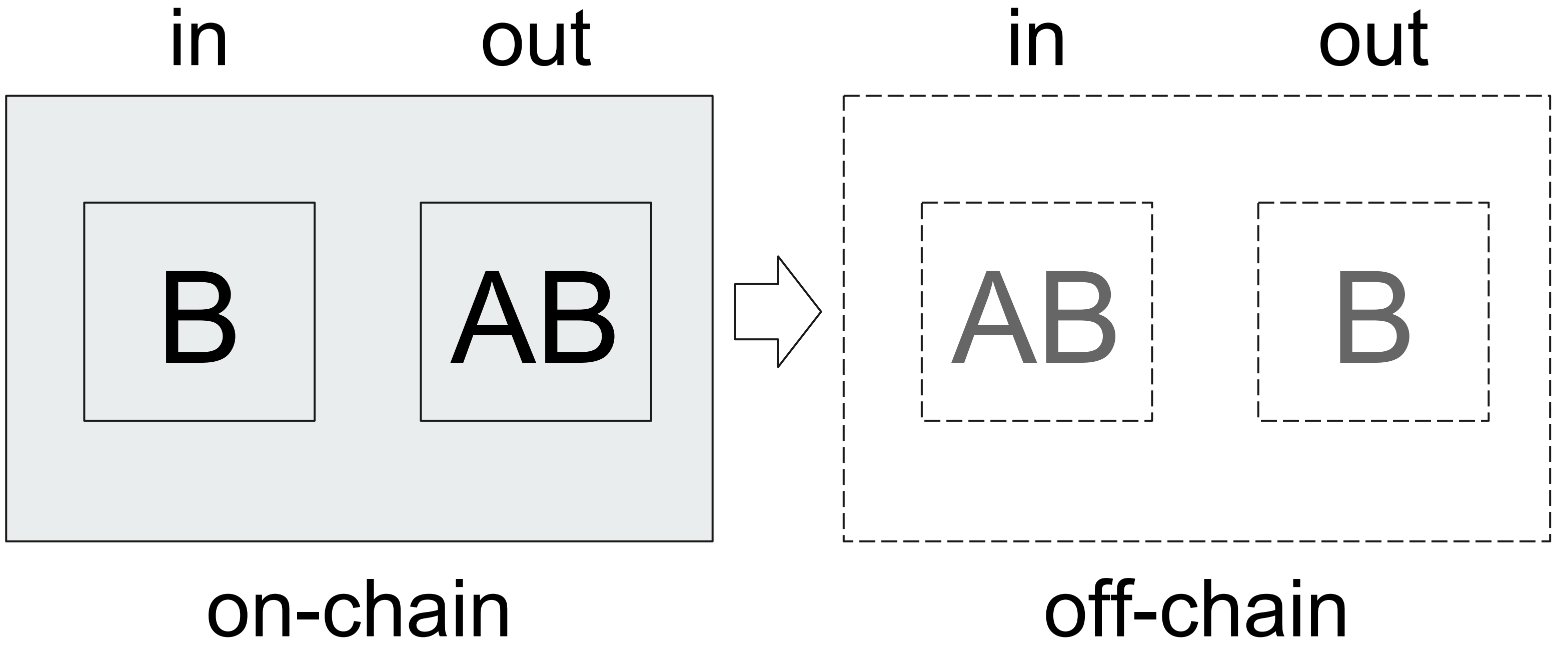
Bob owns it



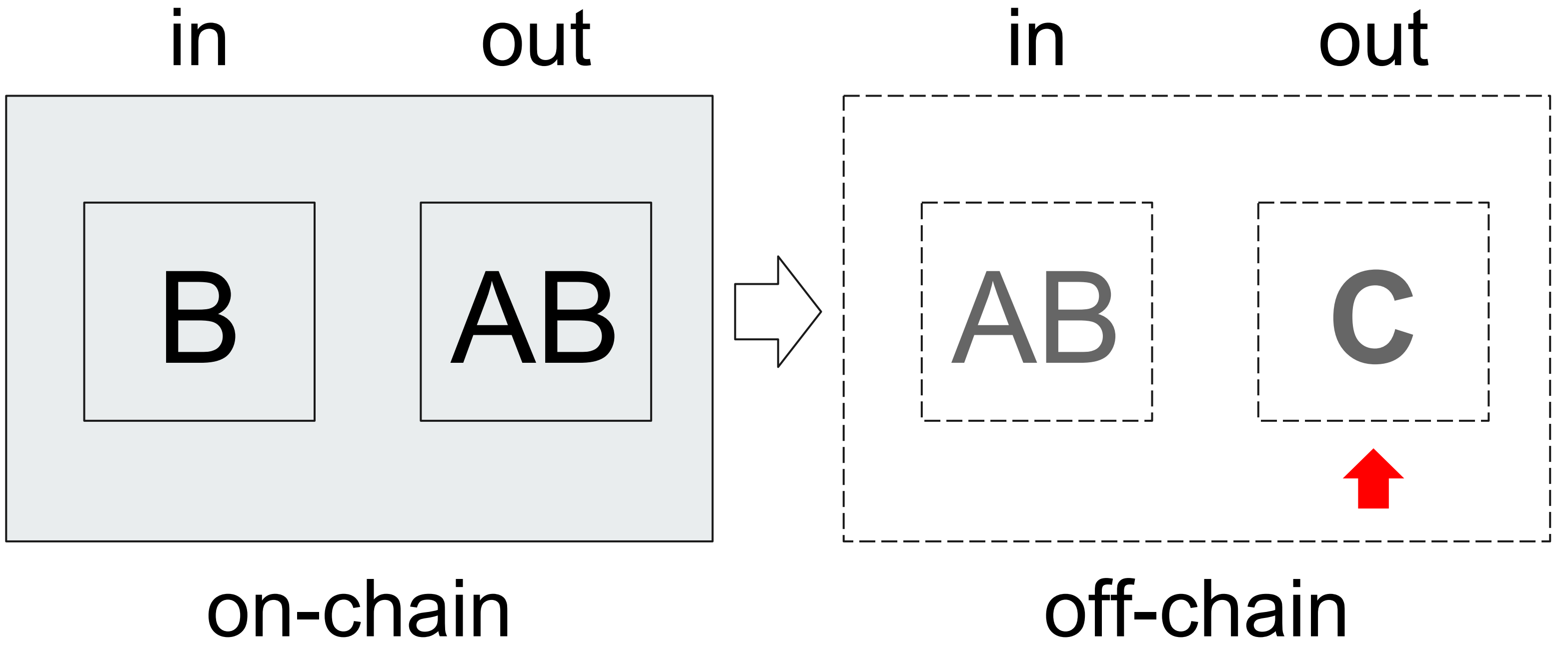
Bob owns it



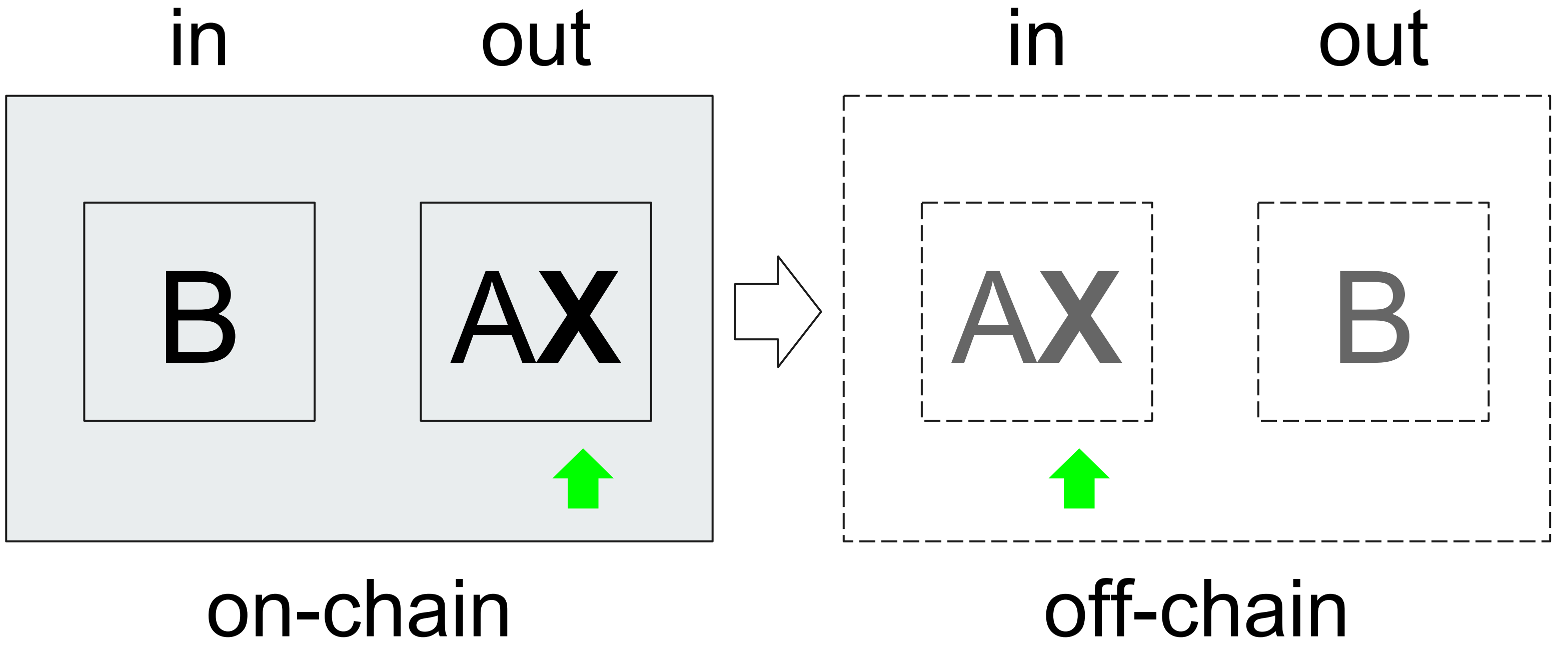
Can Bob transfer this off-chain to Carol?



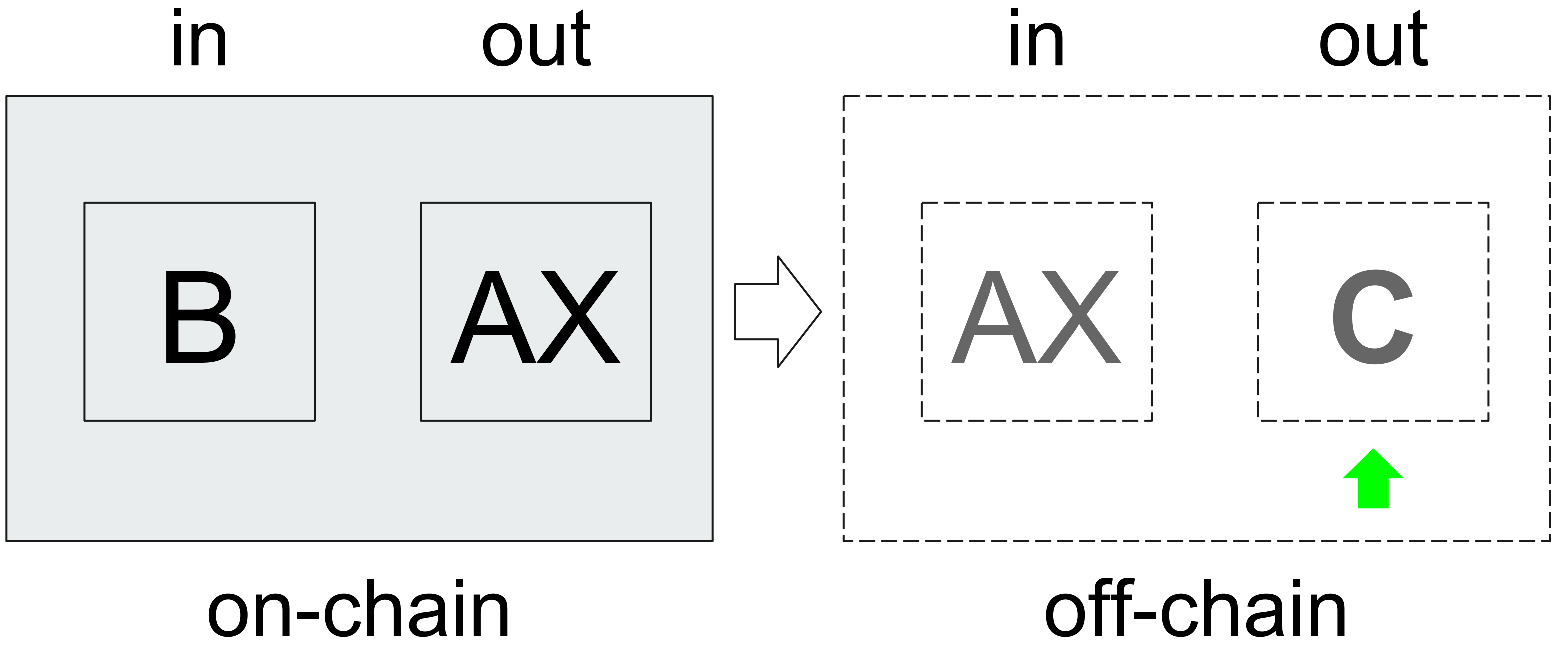
Can Bob transfer this off-chain to Carol?
Sort of, but Carol has no control over it



So Bob uses a transitory key X instead



So Bob uses a transitory key X instead **and passes the key on to Carol**



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Schnorr:
A1+A2+A3=A

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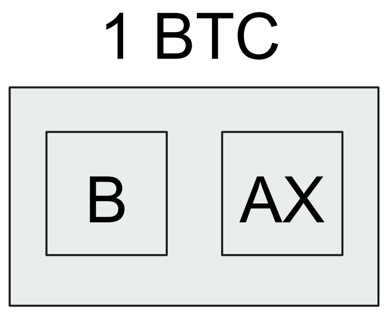
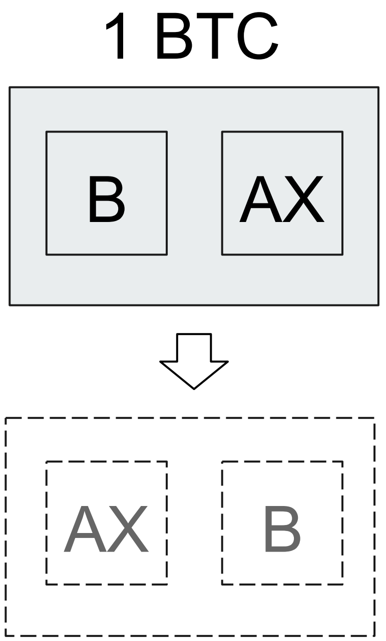
- Promises to *only* cooperate with the last owner
- Can be a federation
- Updates the statechain:
  - listing all UTXOs it controls (no duplicates)
  - every transfer has a signature (e.g. B to C)

Schnorr:
A1+A2+A3=A

Bitcoin



Bitcoin



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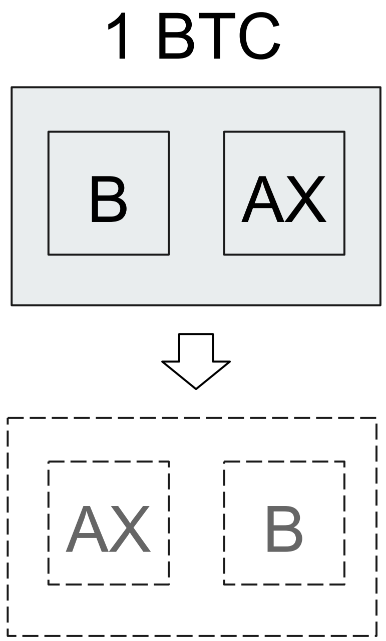
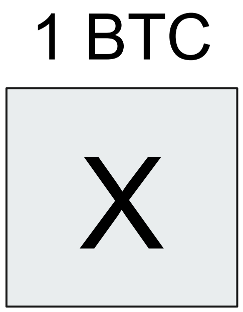


Statechain



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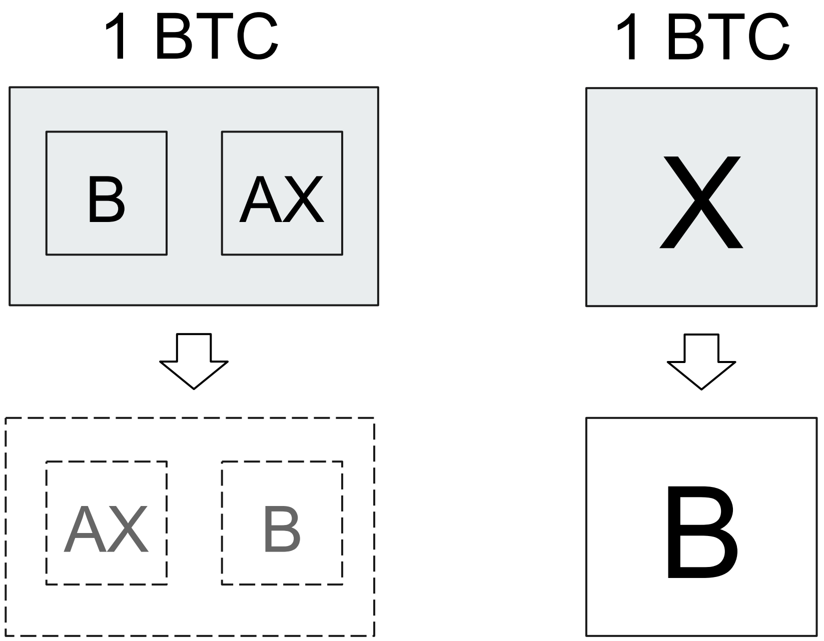
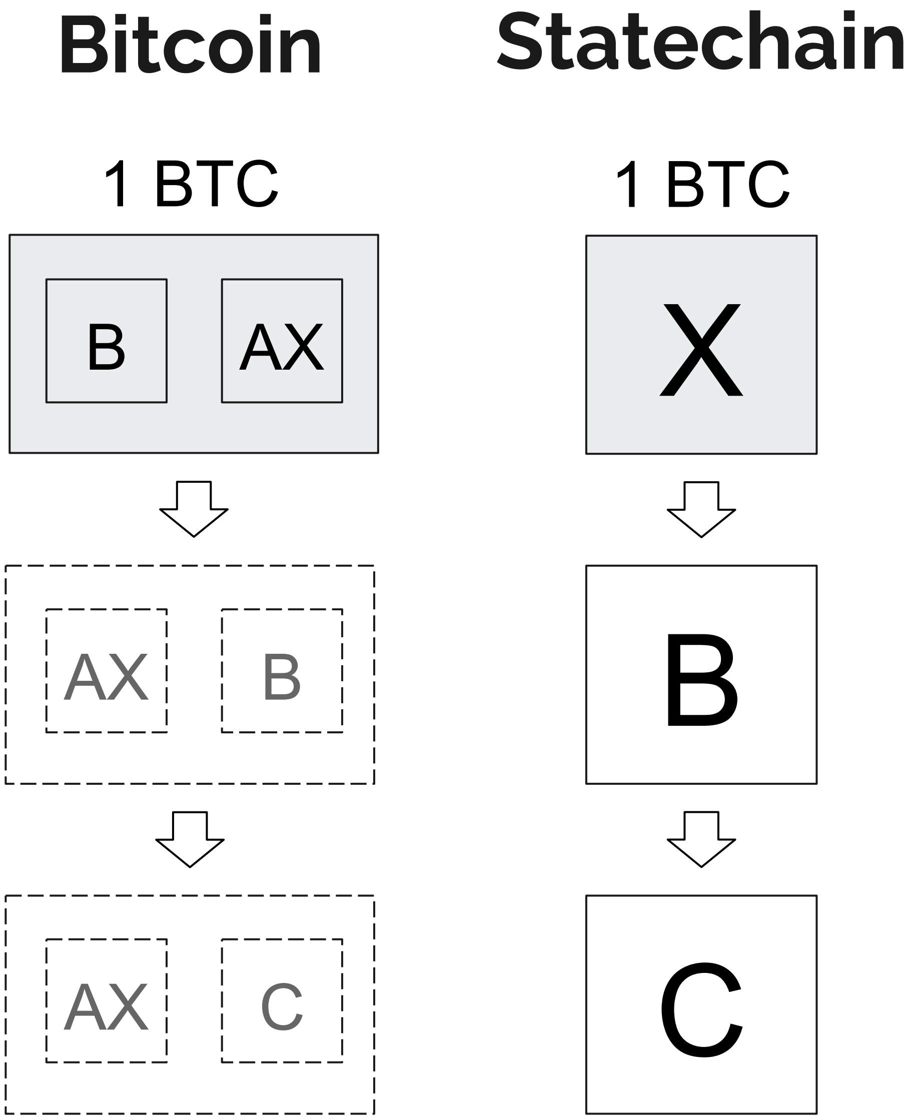
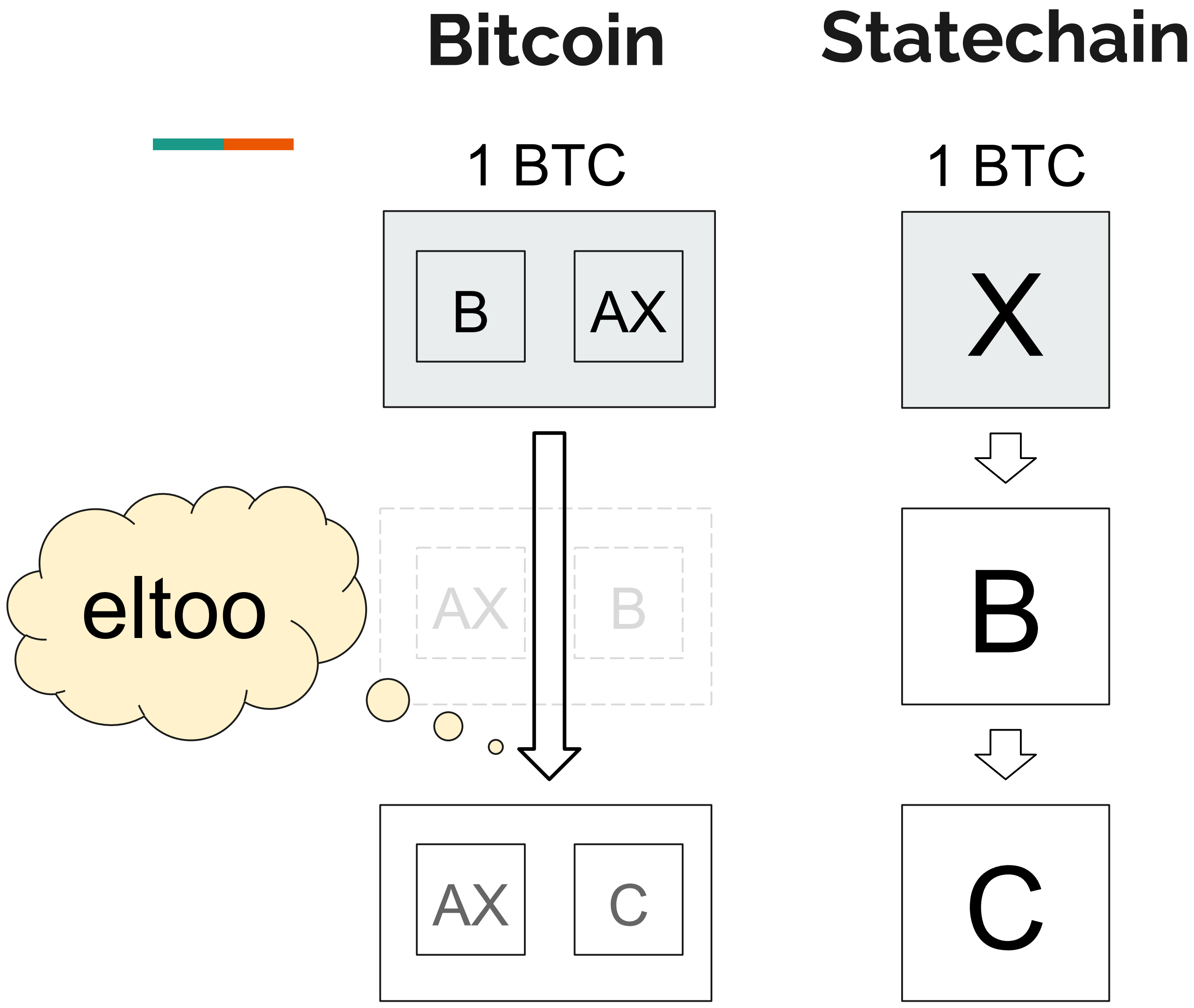



Bitcoin
Statechain
1 BTC
B
AX
AX
B
AX
C
1 BTC
X
B
C


Bitcoin
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1 BTC
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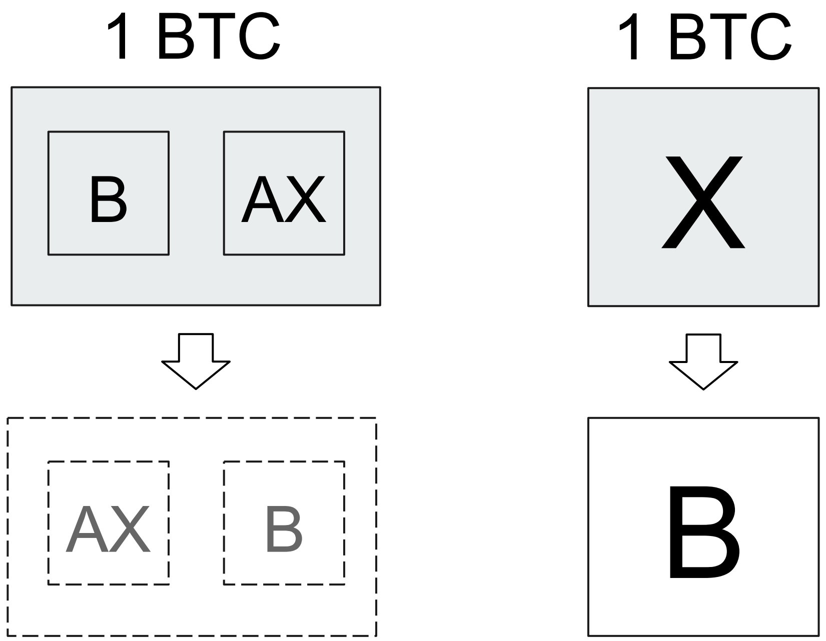
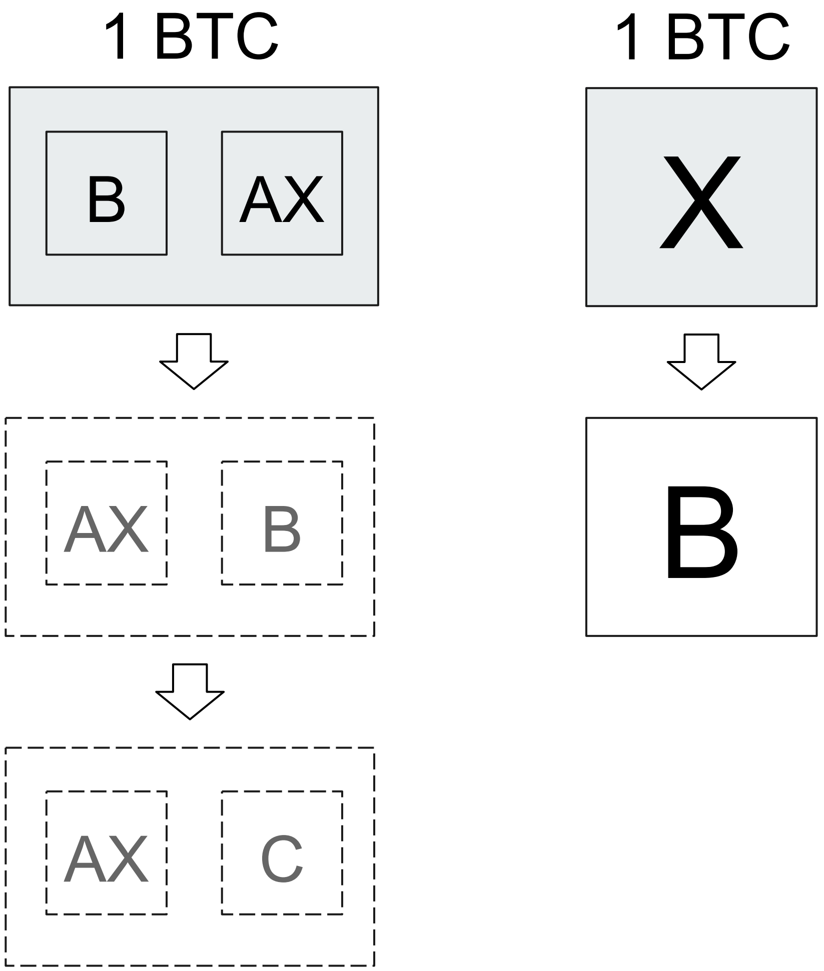
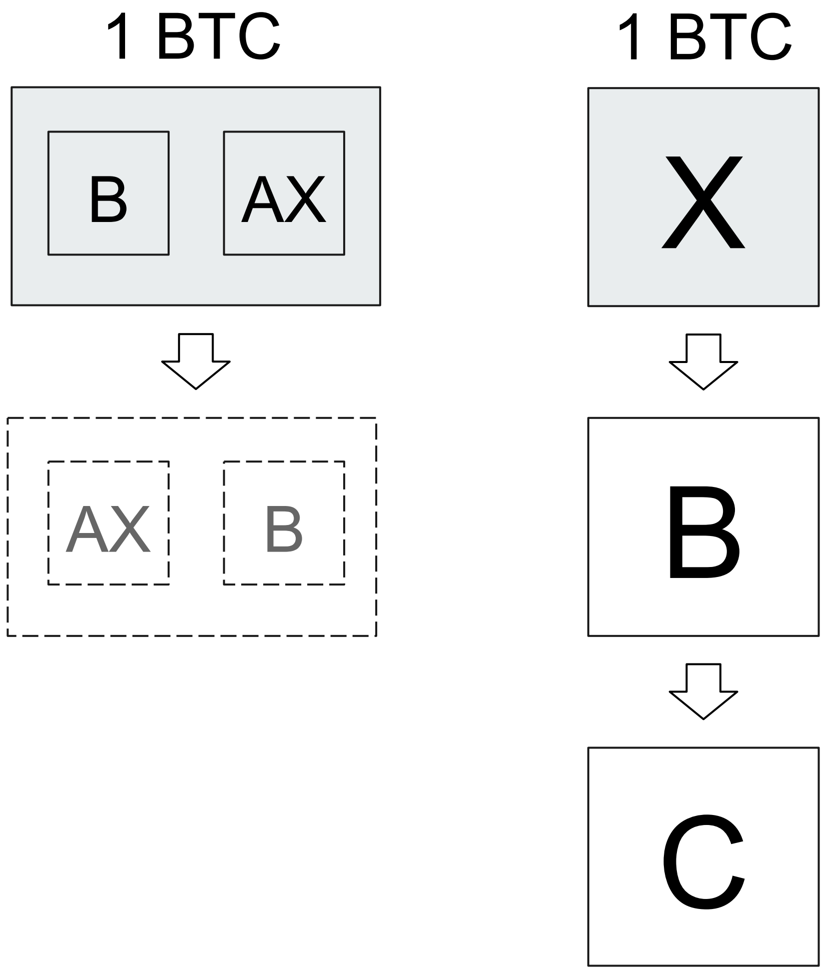
Problem: who goes first?



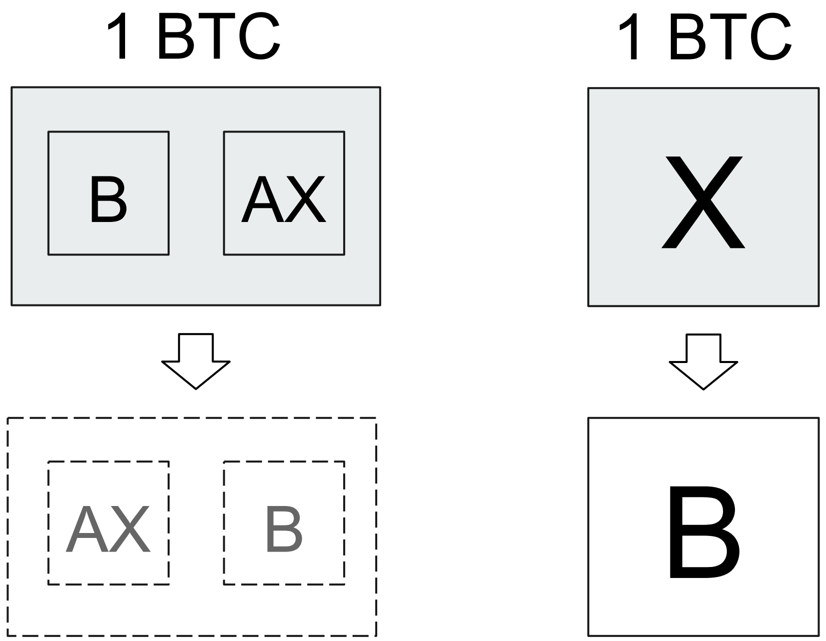
Statechain entity A goes first...?



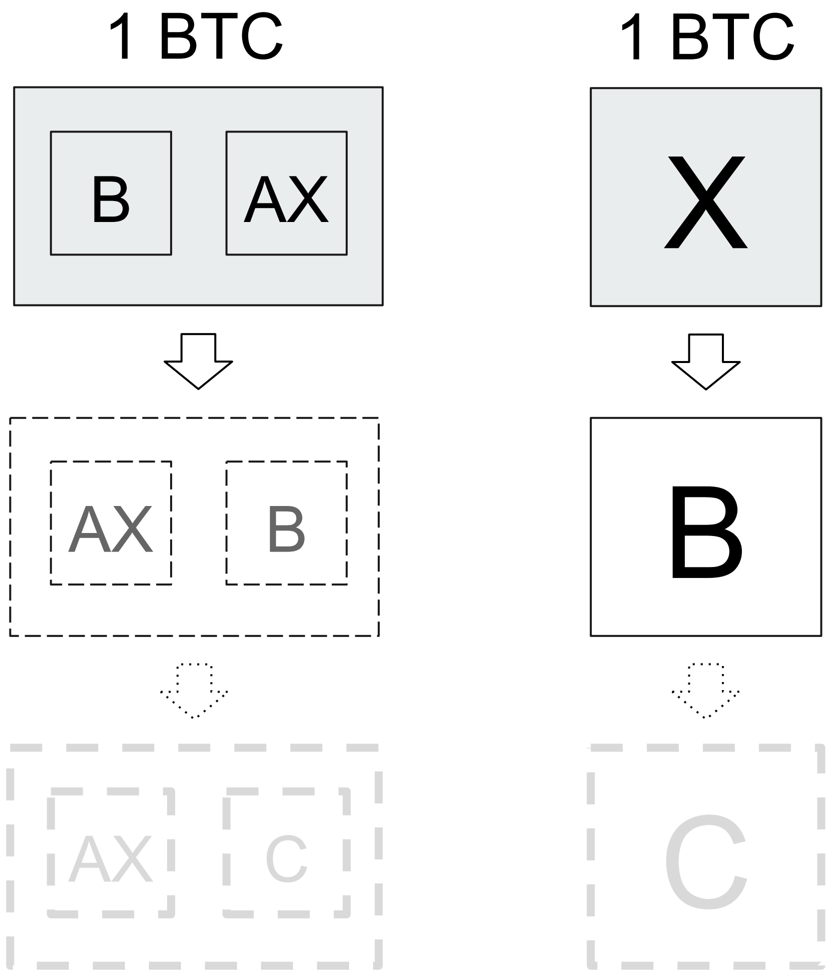
User B goes first...?



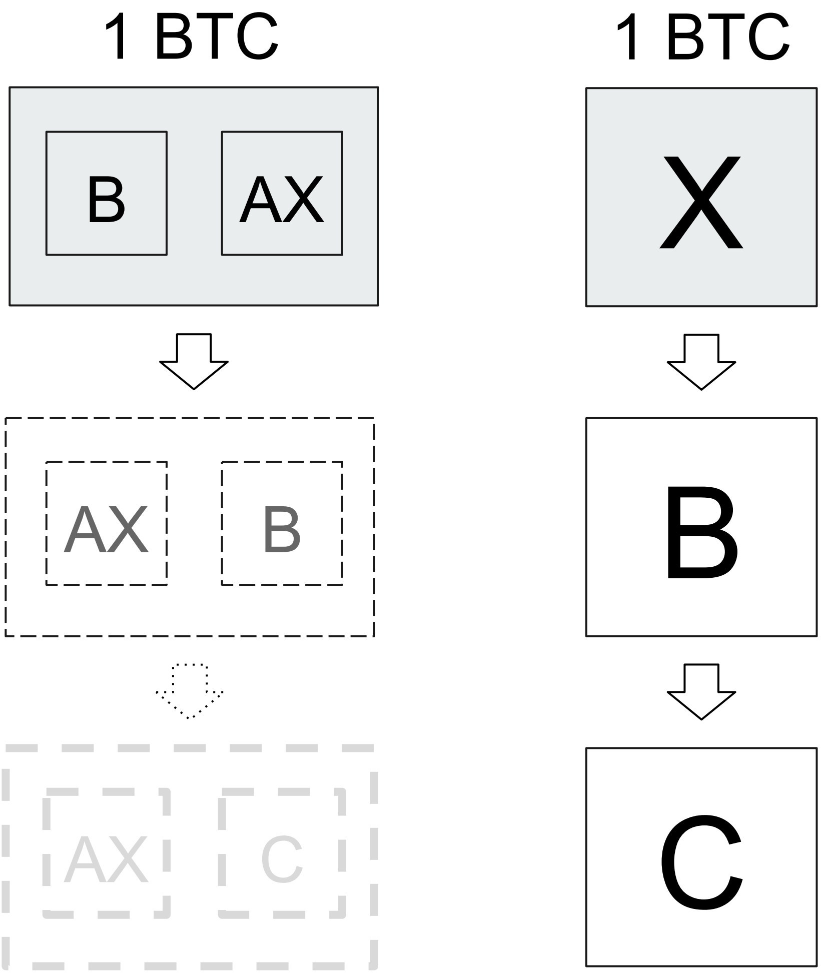
Solution: Adaptor Signatures



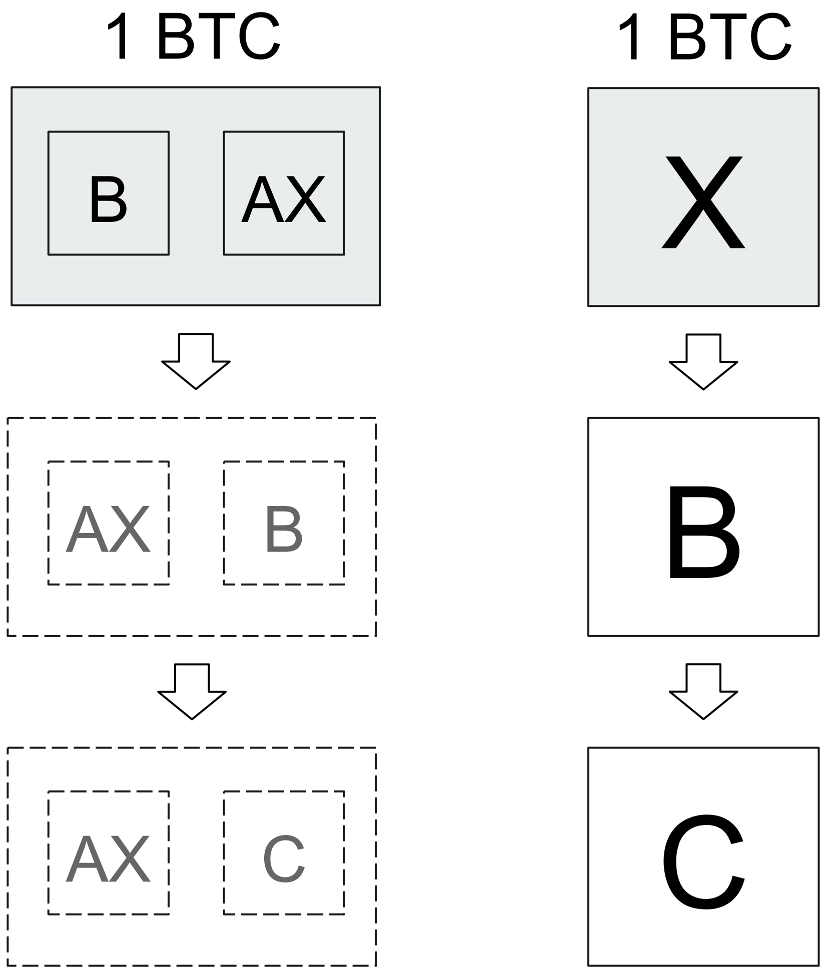
Everyone shares an incomplete signature



Completing the statechain signature...



…automatically completes the bitcoin signature



Security Model

Bitcoin:	*A + X*
Statechain:	*~~B / C / D~~ / E (knows X)*
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- Failure to do so will produce evidence of fraud

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Harmless without transitory keys (weak assumption):

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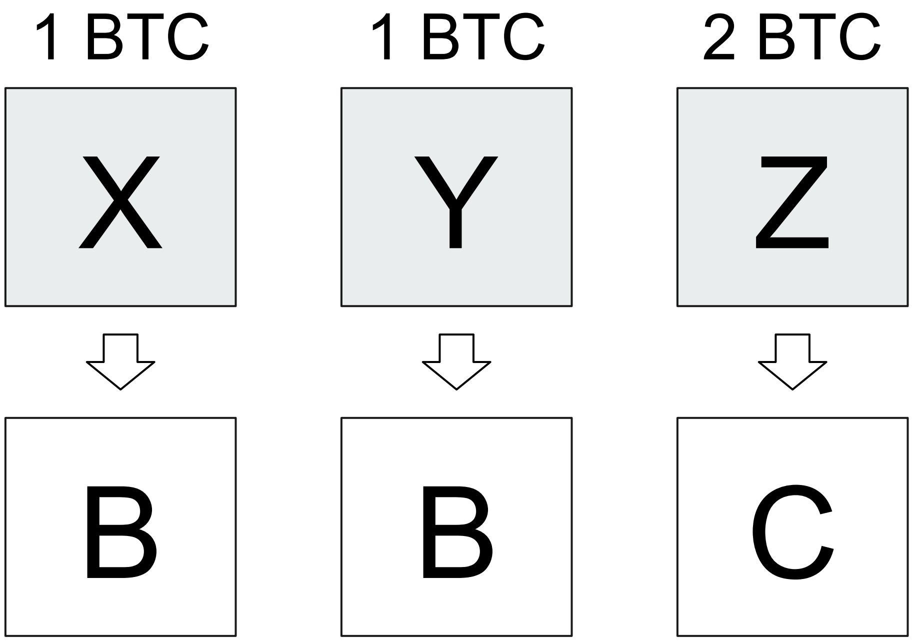
- Court order to freeze/confiscate coins

Swapping to smaller amounts



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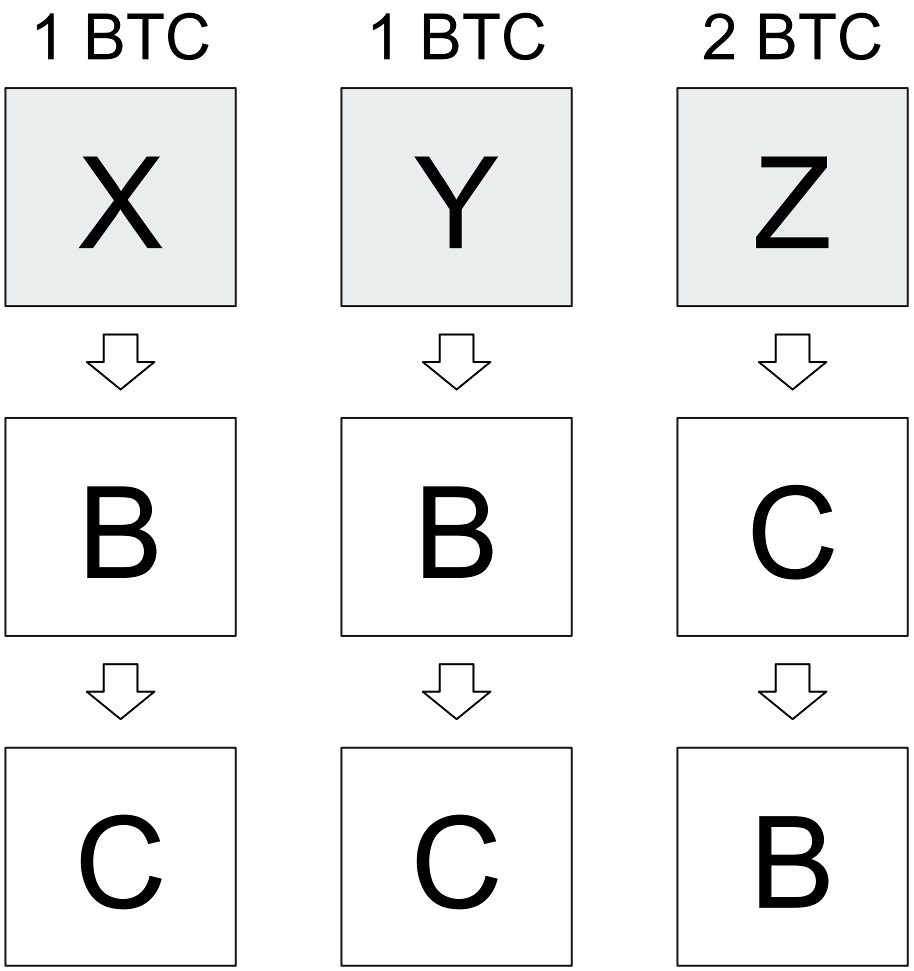
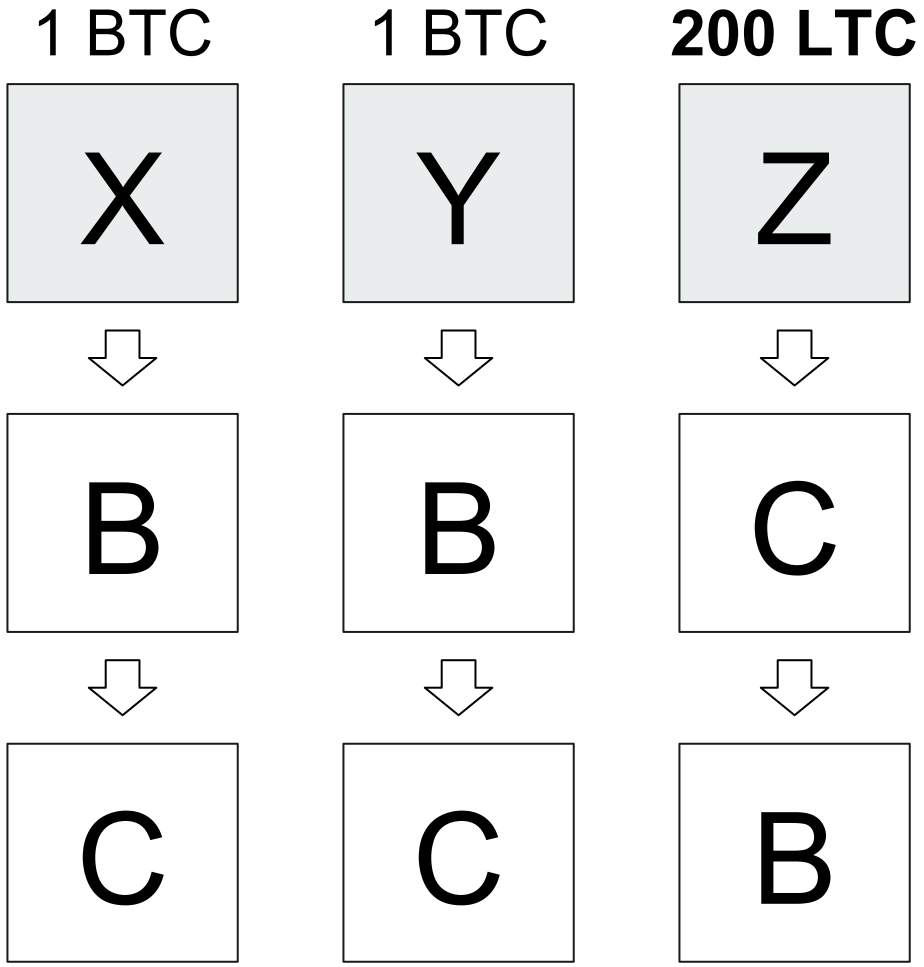


Possible with other coins



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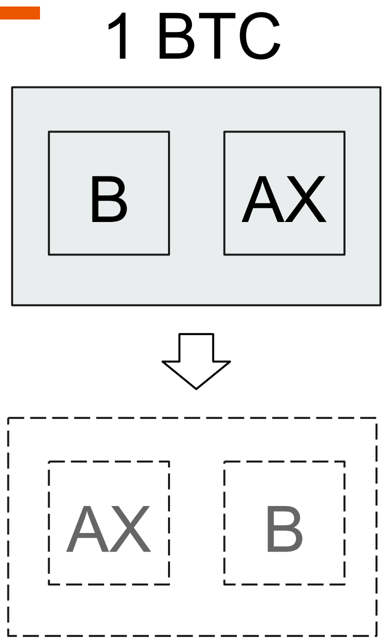
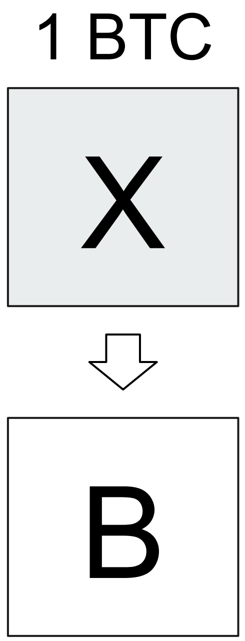
"Anything smaller than an economically viable UTXO"

- Required if Statechain entity wants to charge fees
- Needed when swapping between multiple currencies
- Ideally solved without trusting the statechain entity

  (important legal reason: no custody over ANY coins)

Lightning Channel Creation





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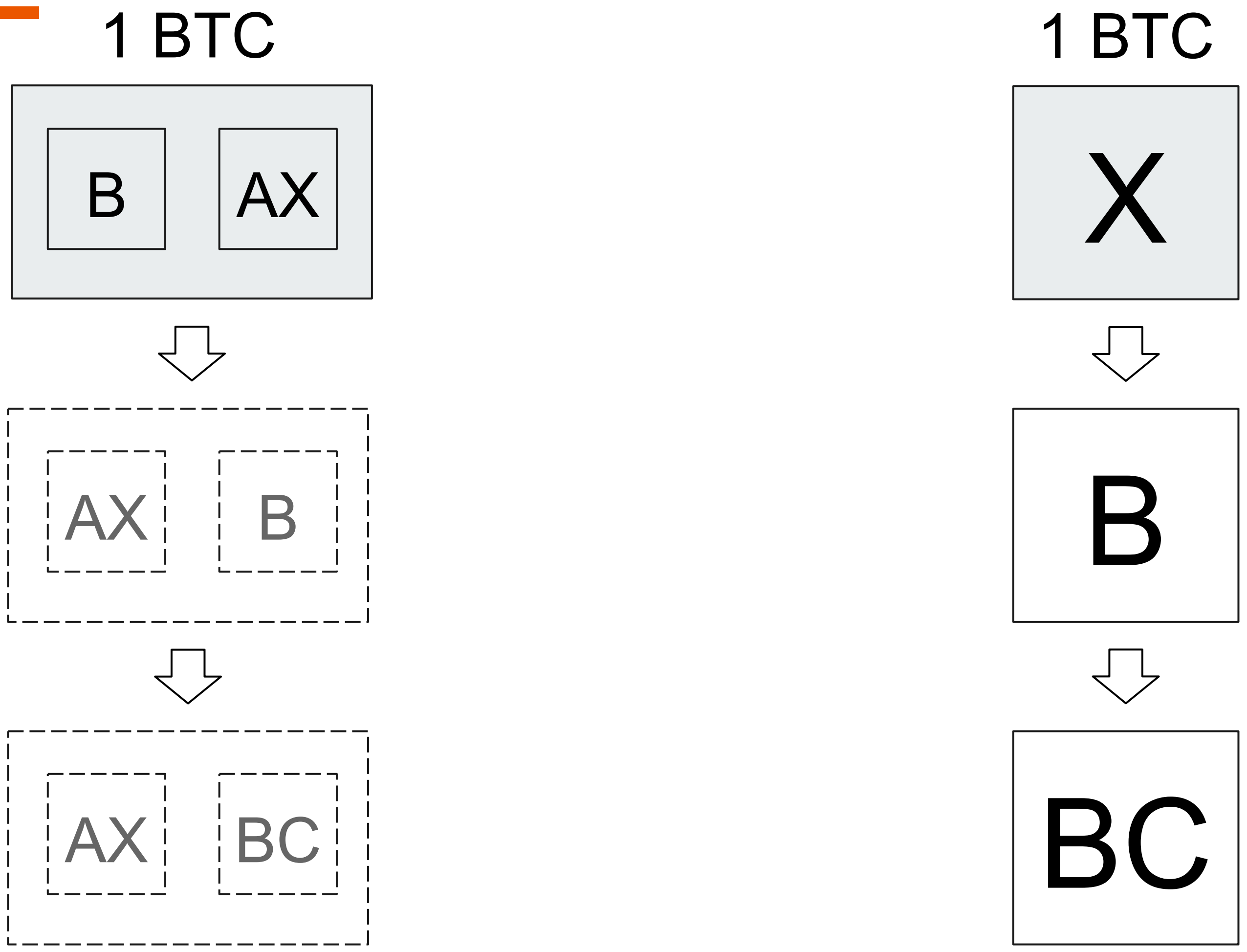

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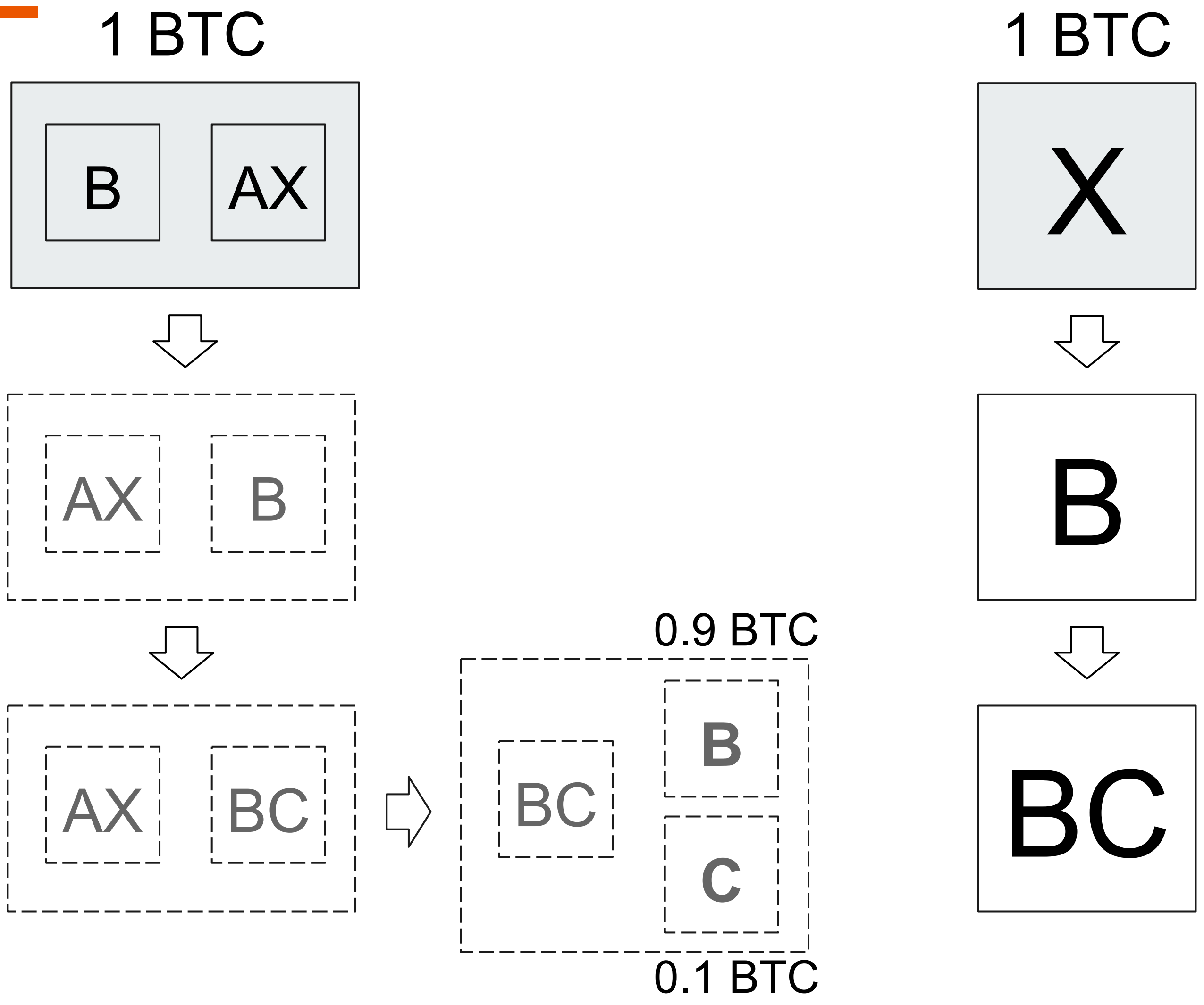

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- Small channels: up to the amount of the smallest UTXO
- Uncooperative close similar to regular Eltoo
- Close/reopen channel low-friction: it’s all off-chain!

  (e.g. adding/removing bitcoins)

Potential Use Cases

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- Platform for Lightning channels
- Betting channels (multisig, Discreet Log Contracts)
- Fork-agnostic ETF (UTXOs don’t move)

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- Use HSM to transfer transitory key (attestation)
- Graftroot withdrawal (allows redeeming forks)
- Succinctly store and relay statechain (per UTXO)
- Variant using blind signatures:

  Entity unaware which UTXOs it holds (unblind p2p)

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Thank You

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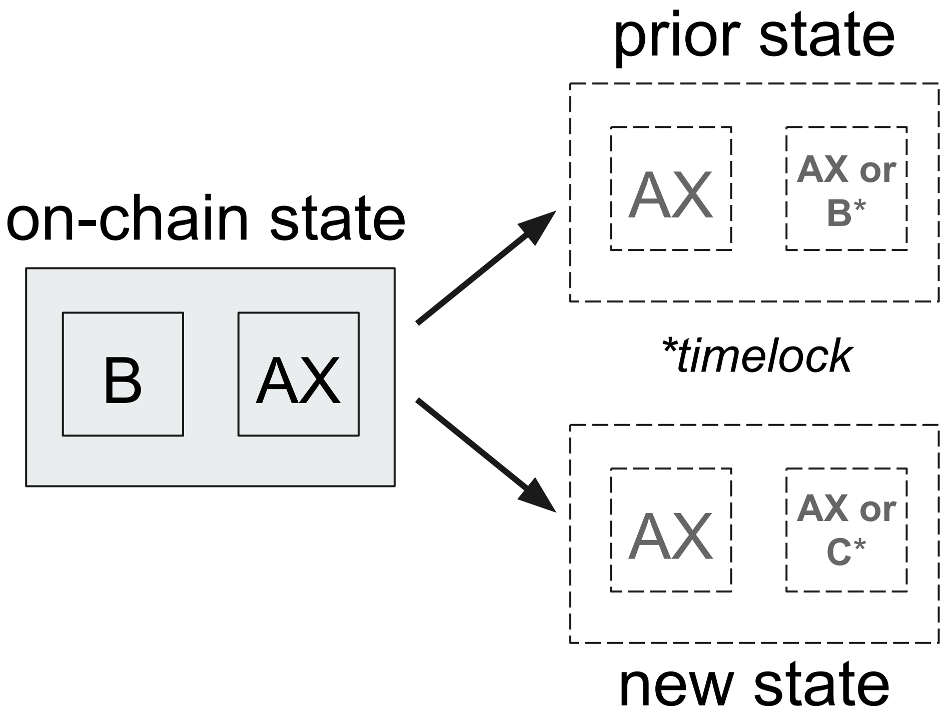
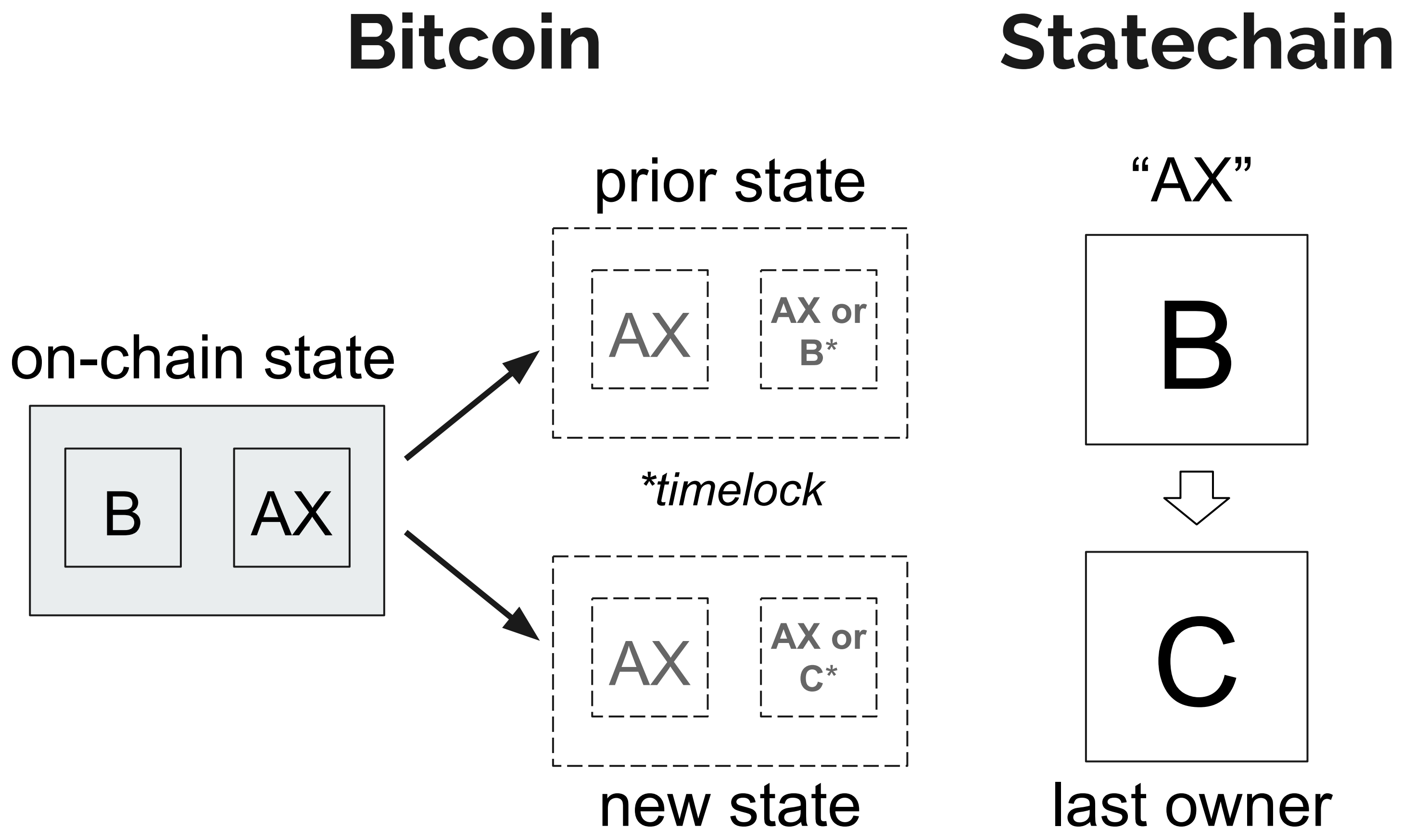
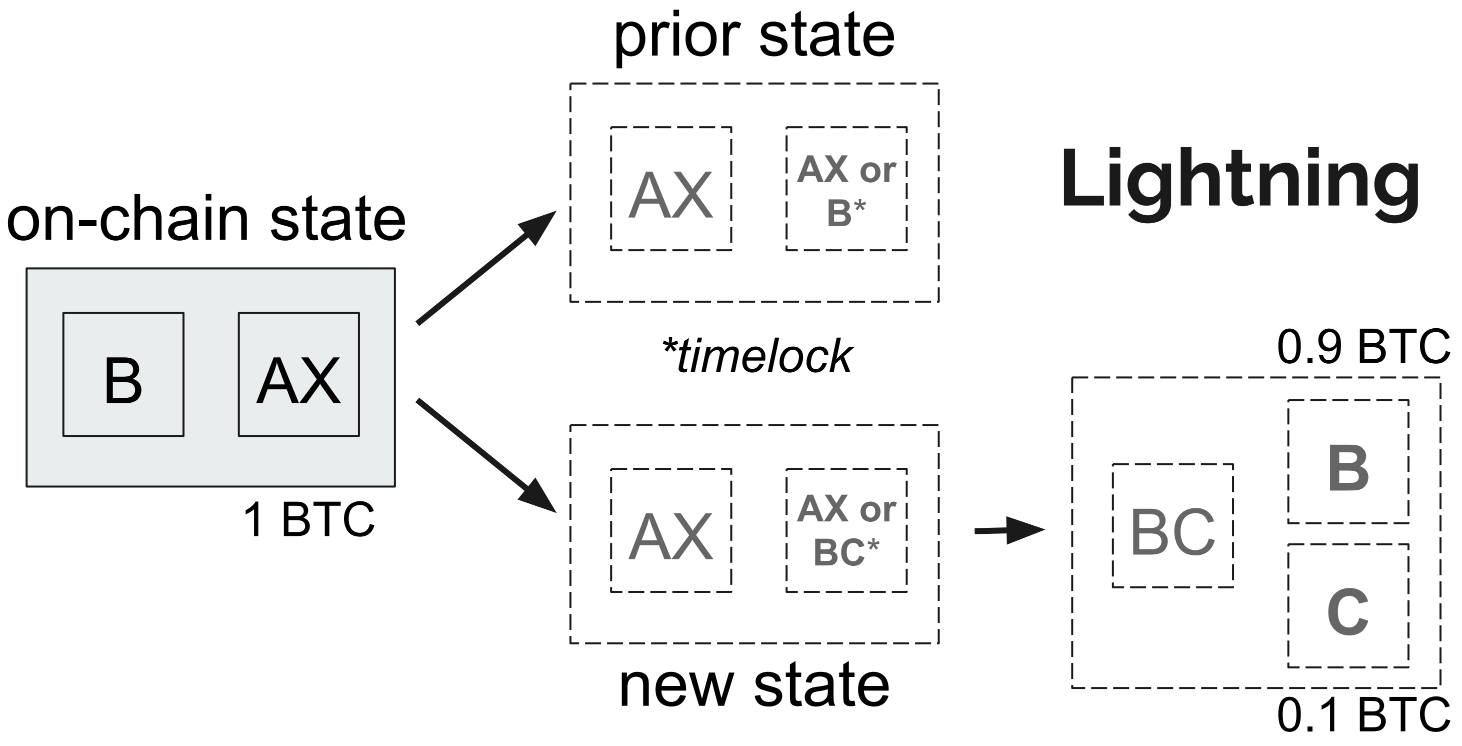
Bitcoin



prior state
AX
AX or B*
on-chain state
B
AX
*timelock
AX
AX or C*
new state


Bitcoin
Statechain
on-chain state
B
AX
prior state
AX
AX or B*
*timelock
AX
AX or C*
new state
"AX"
B
C
last owner

Lightning


prior state
on-chain state
B
AX
1 BTC
AX
AX or B*
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AX
AX or BC*
new state
0.9 BTC
BC
B
C
0.1 BTC