Outpost: A Lightweight Responsive Watchtower

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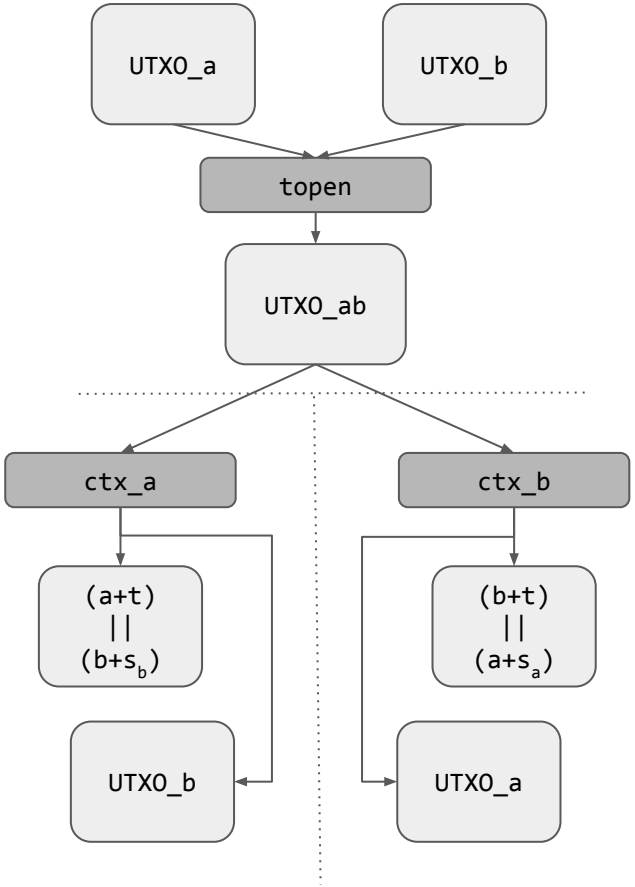
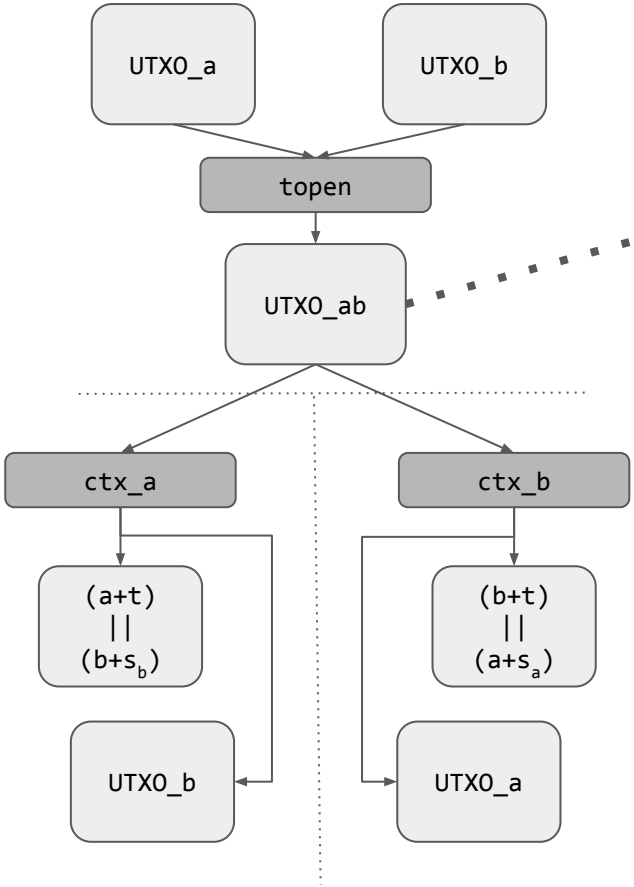
What’s happening?

- 7 TPS
- Channels
- Can’t go offline
- Watchtower
- Watchtower needs to store A LOT
- Does it?
- Alice/Bob have to store things to be able to cheat
- Blockchain!!

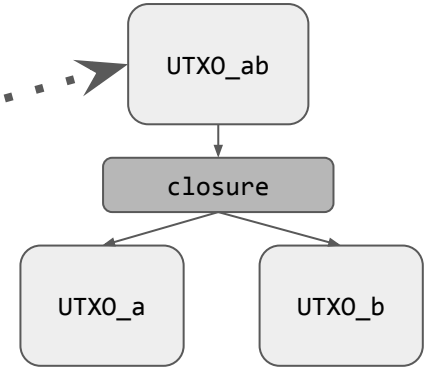
Lightning Channel



Lightning Channel



Bilateral Closure



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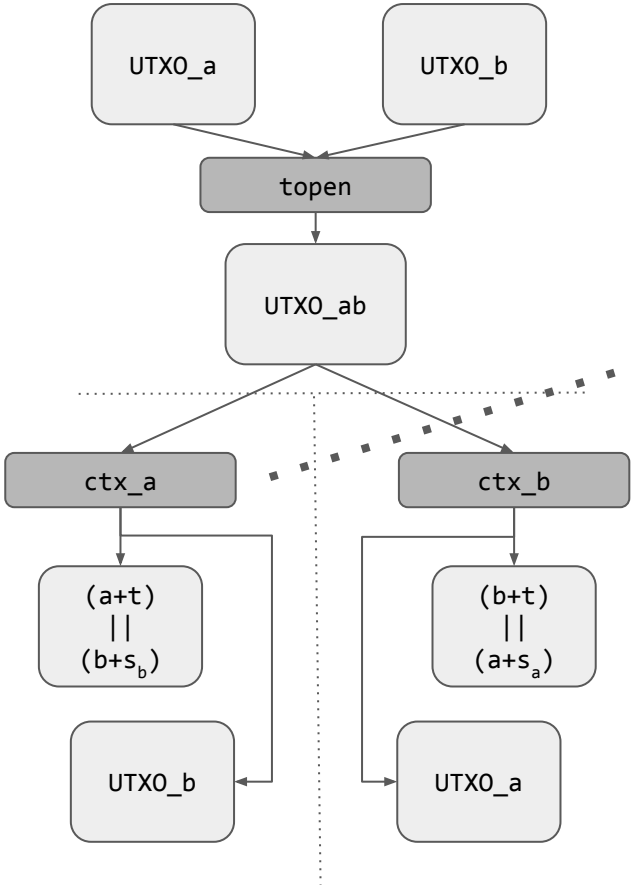
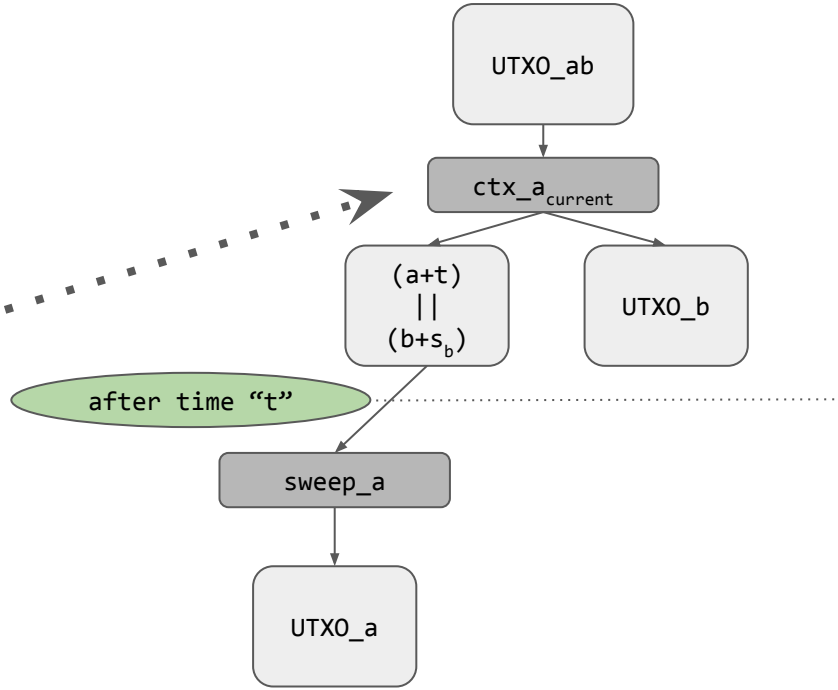
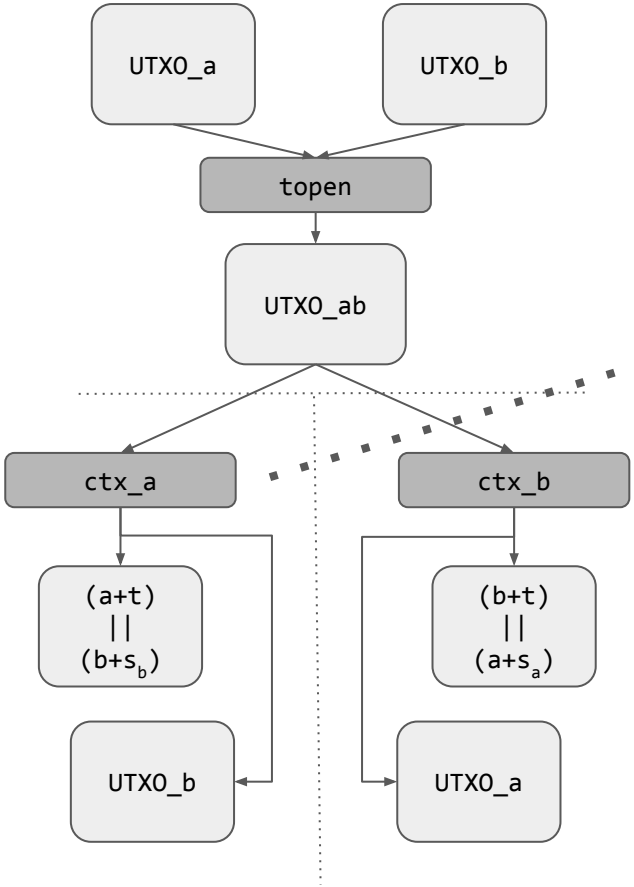


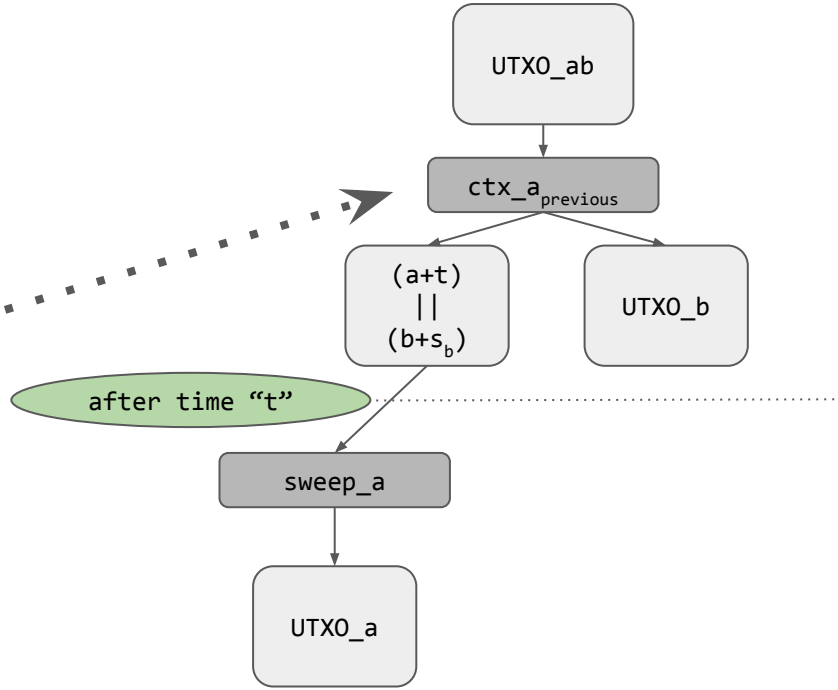
Unilateral Closure



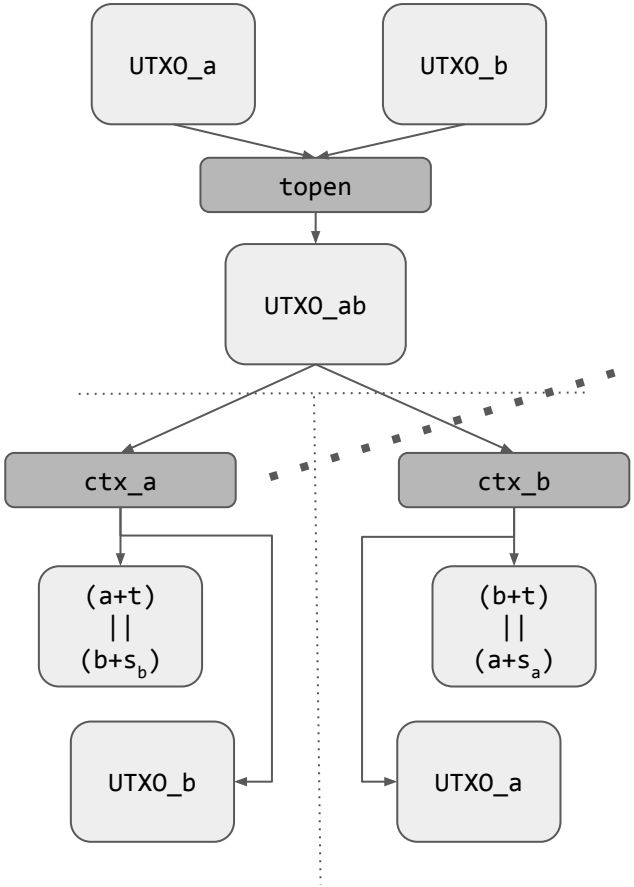
Lightning Channel



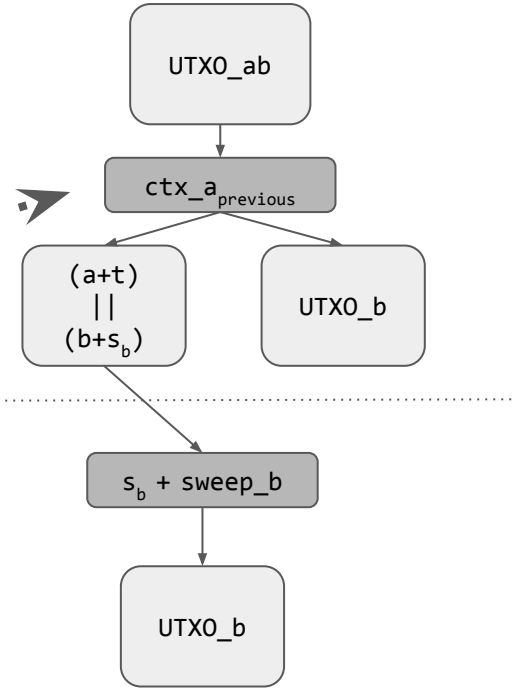
Cheating Closure



Lightning Channel



Justice Transaction



Can we store JTX inside CTX?

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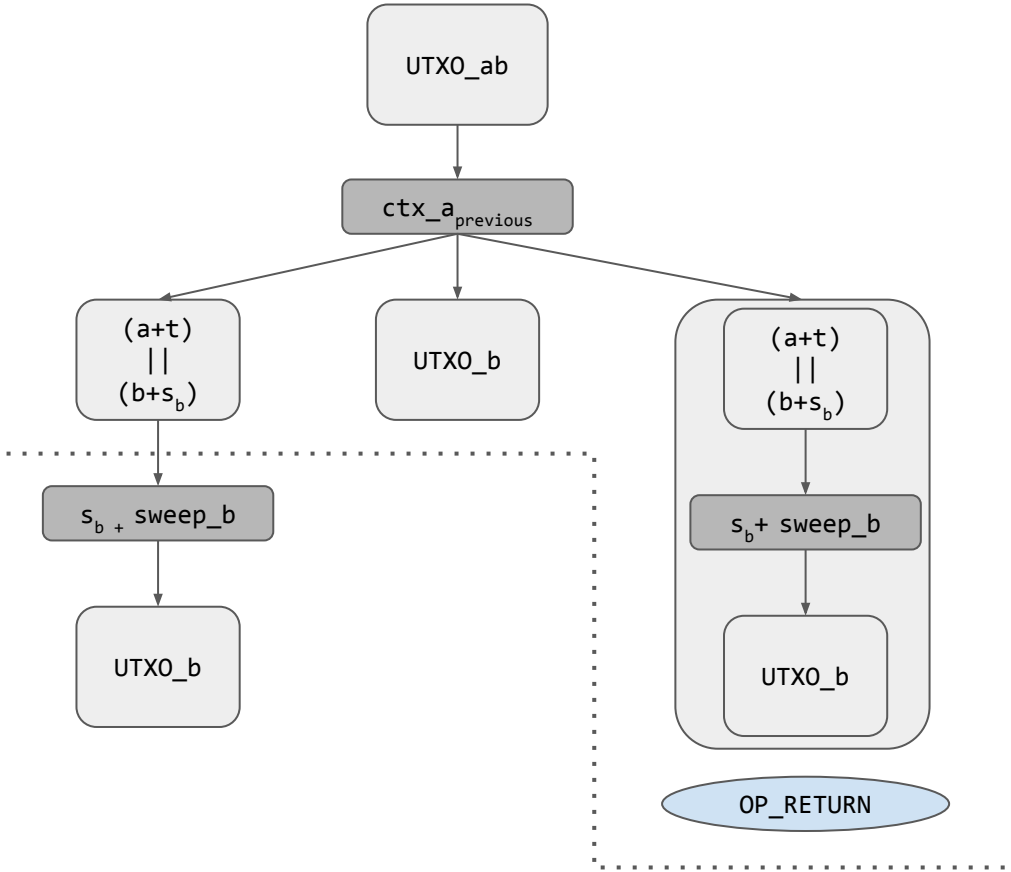
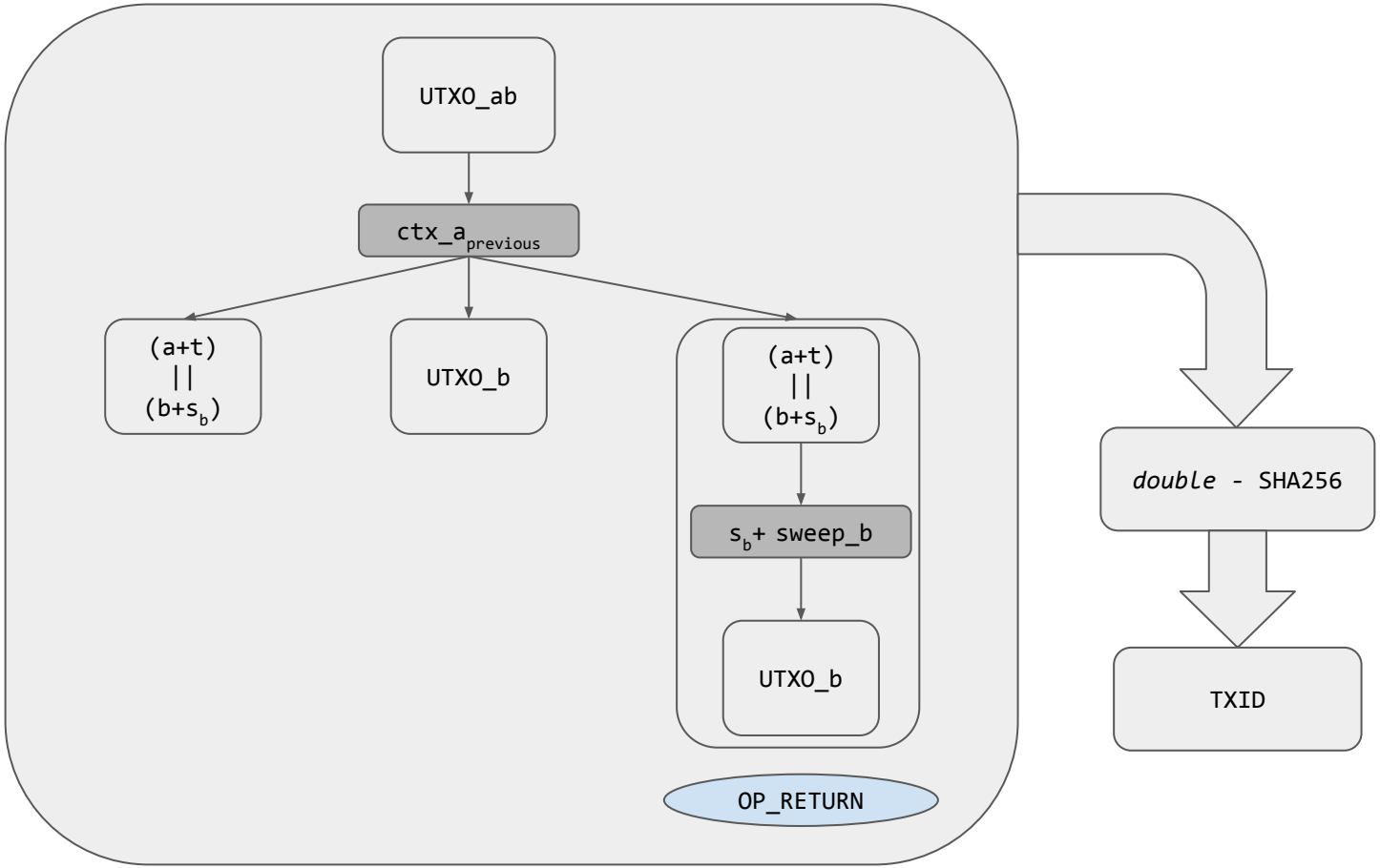
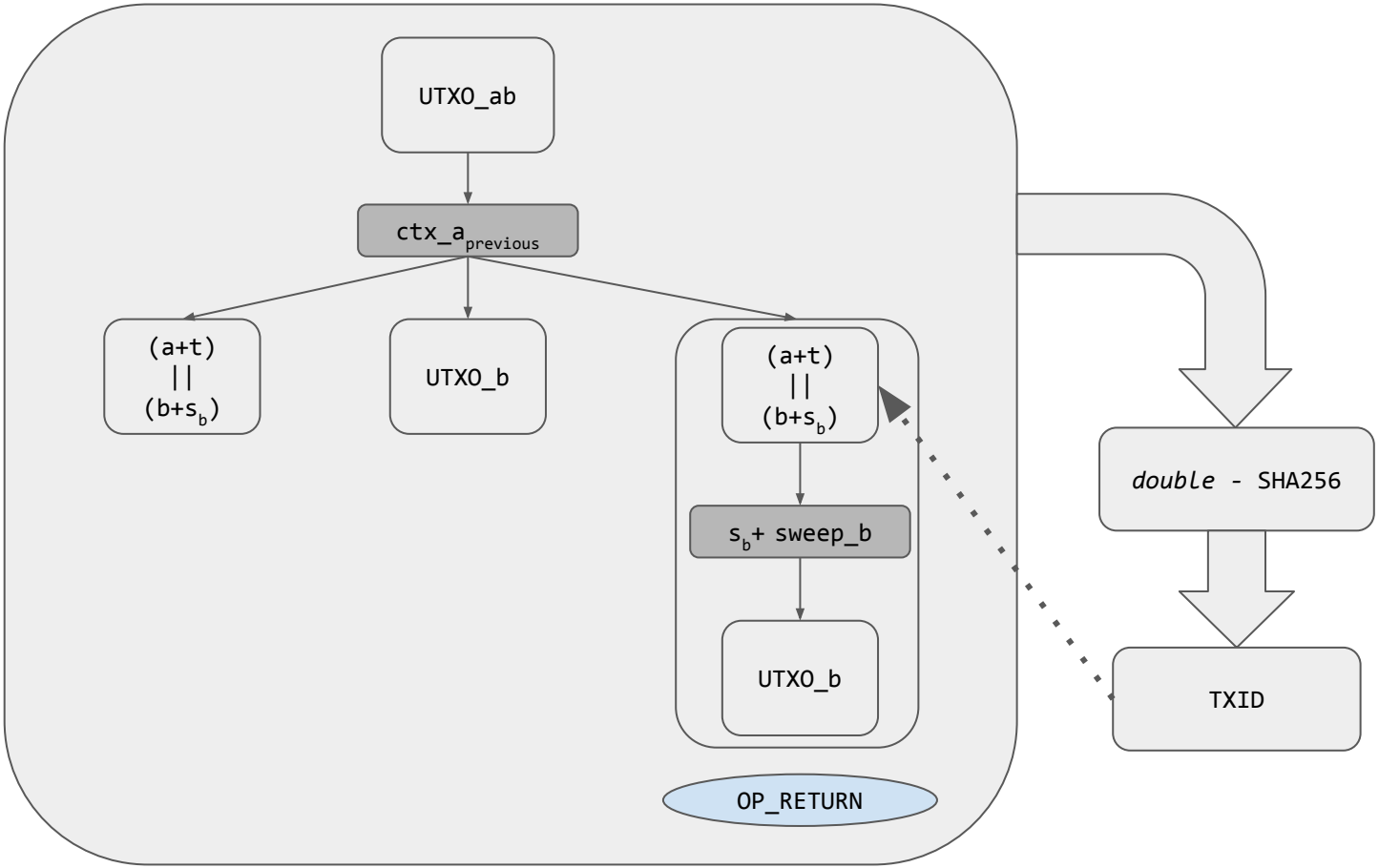


TXID


UTXO_ab
ctx_a previous
(a+t)
||
(b+s_b)
UTXO_b
(a+t)
||
(b+s_b)
s_b+ sweep_b
UTXO_b
OP_RETURN
double - SHA256
TXID

TXID makes it self-referential



OP_RETURN alternatives

P2SH Data Drop

- vulnerable to scriptSig malleability

P2SH Data Hash

- vulnerable to self-loop in the redeem_script hash

Outpost

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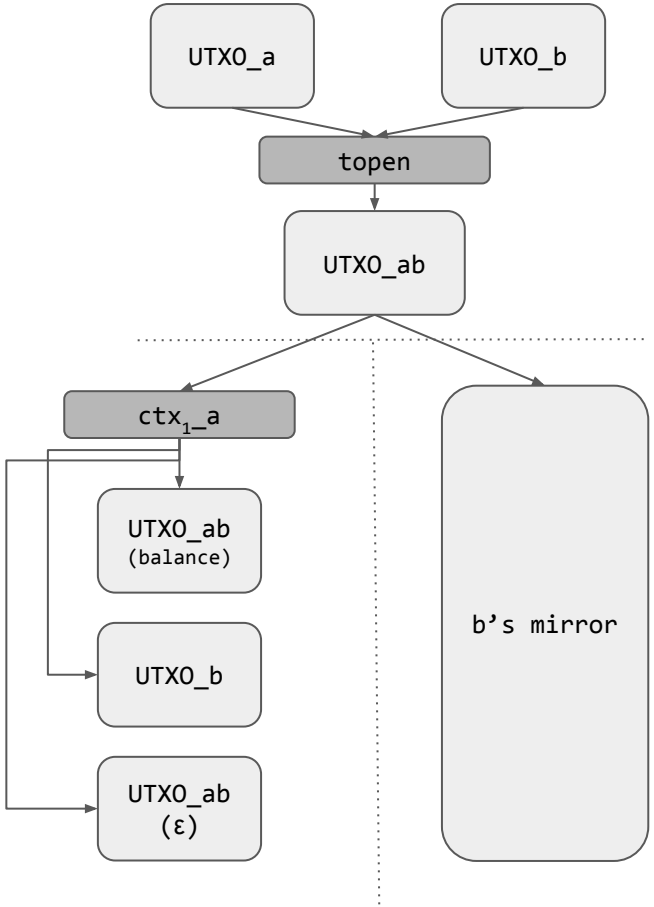
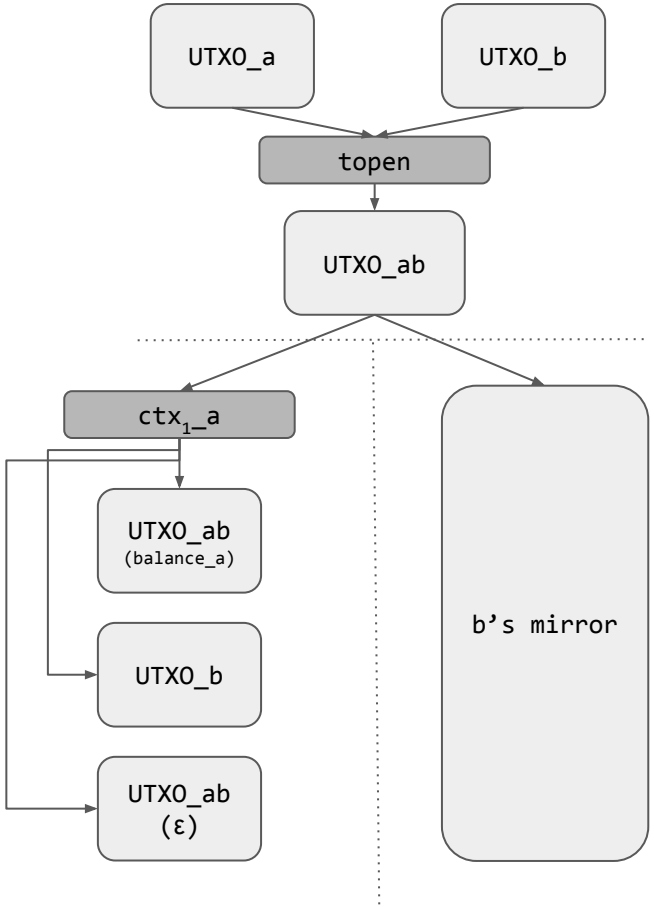
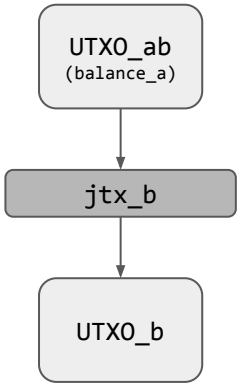

UTXO_a
UTXO_b
topen
UTXO_ab
ctx1_a
UTXO_ab
(balance)
UTXO_b
UTXO_ab
(ε)
b's mirror

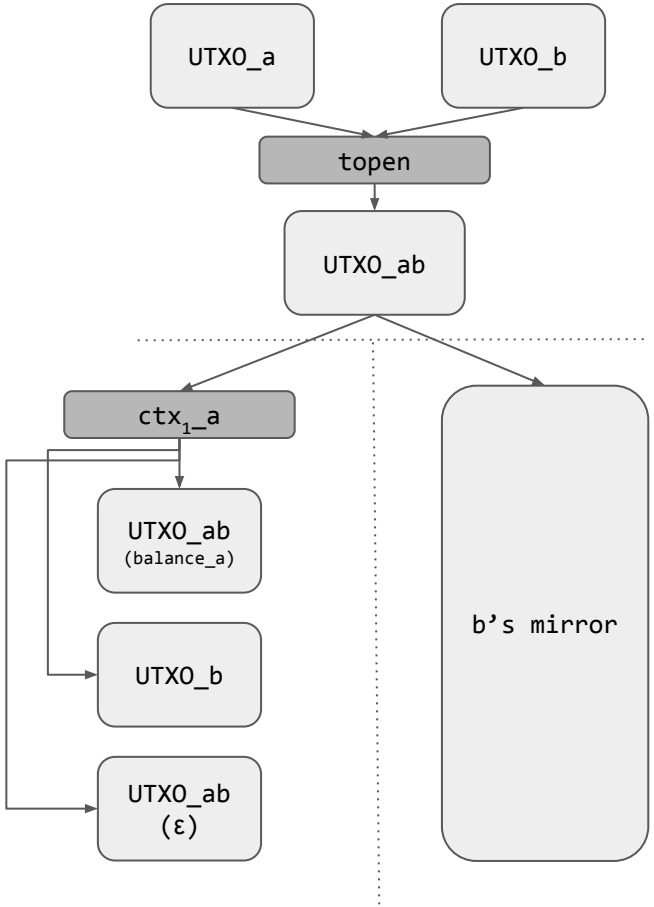
Outpost



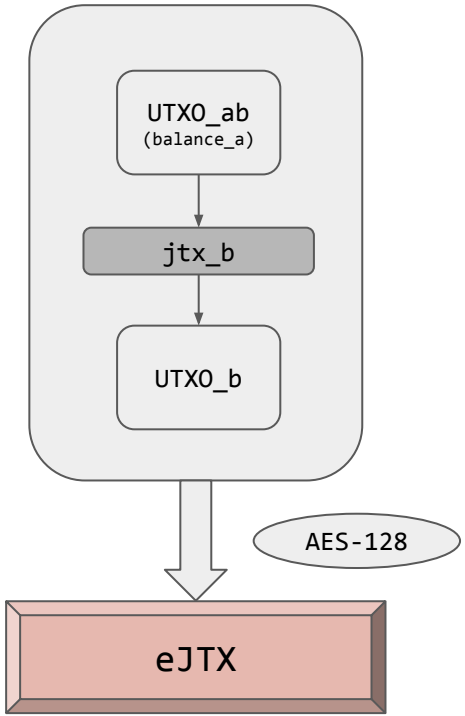
Justice Transaction



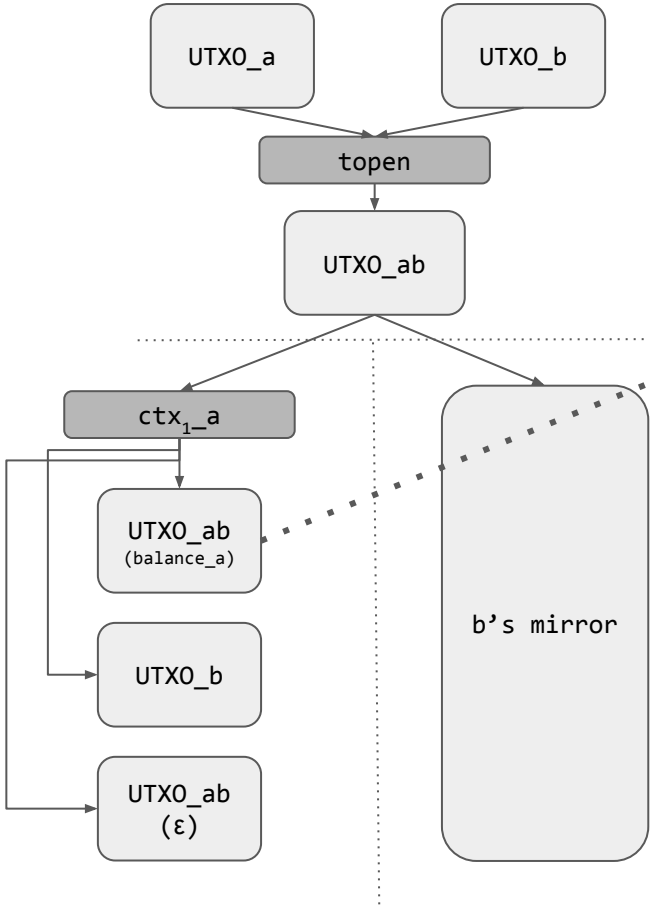
Outpost



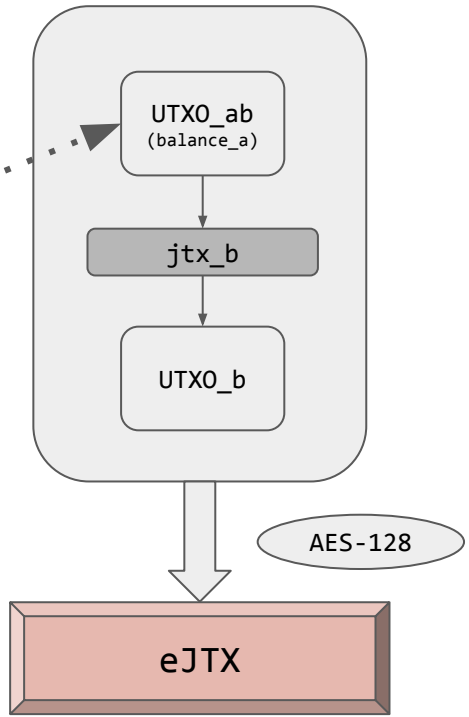
Encrypted Justice Transaction



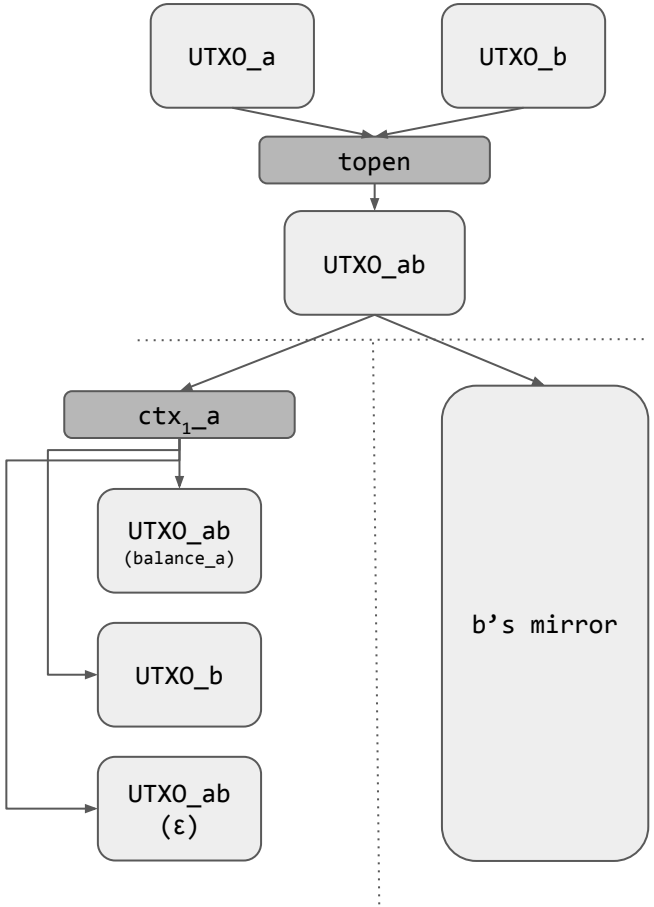
Outpost



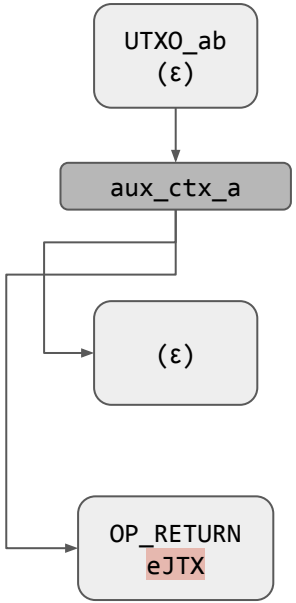
Encrypted Justice Transaction

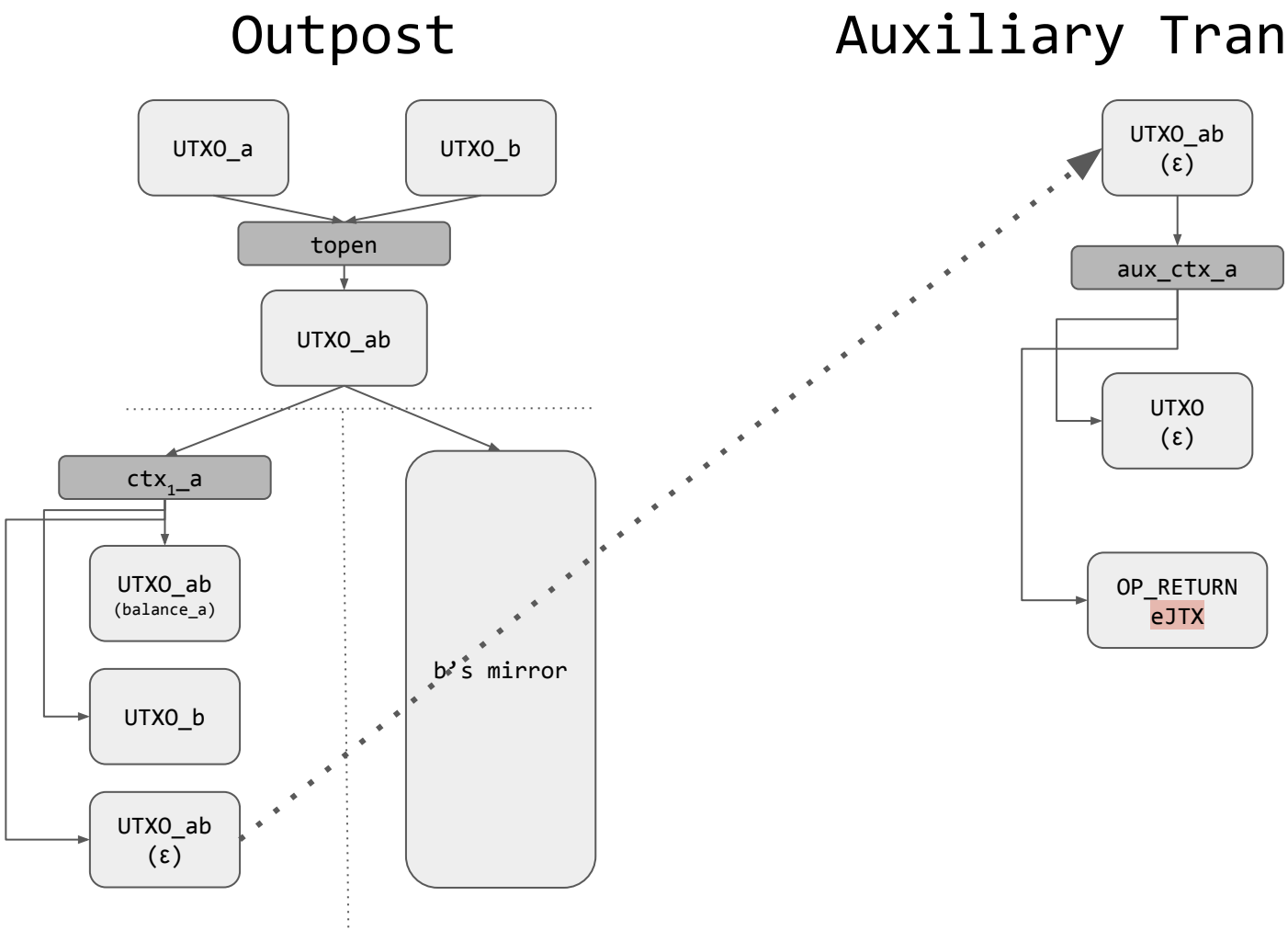


Outpost

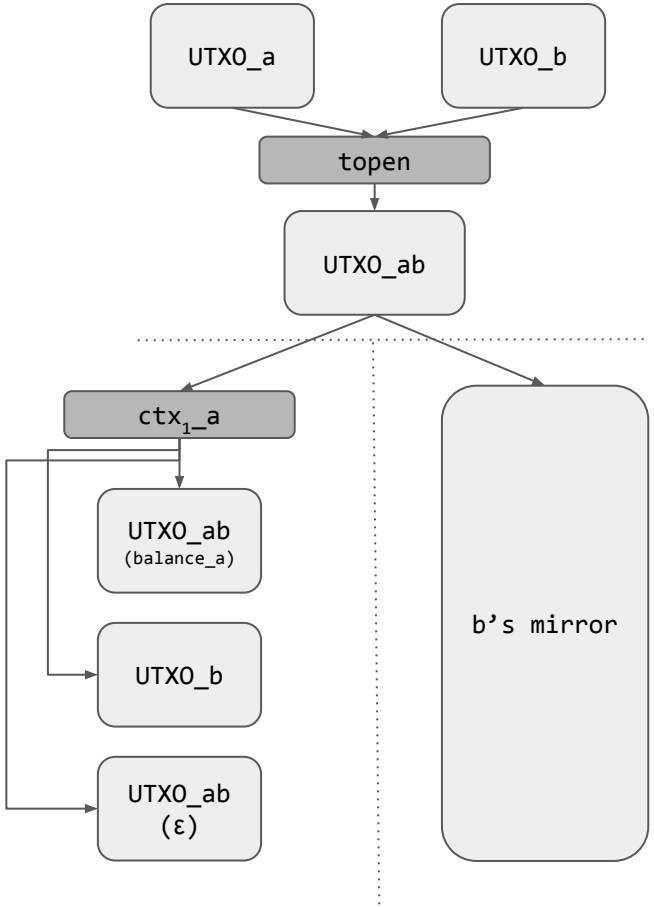


Auxiliary Transaction

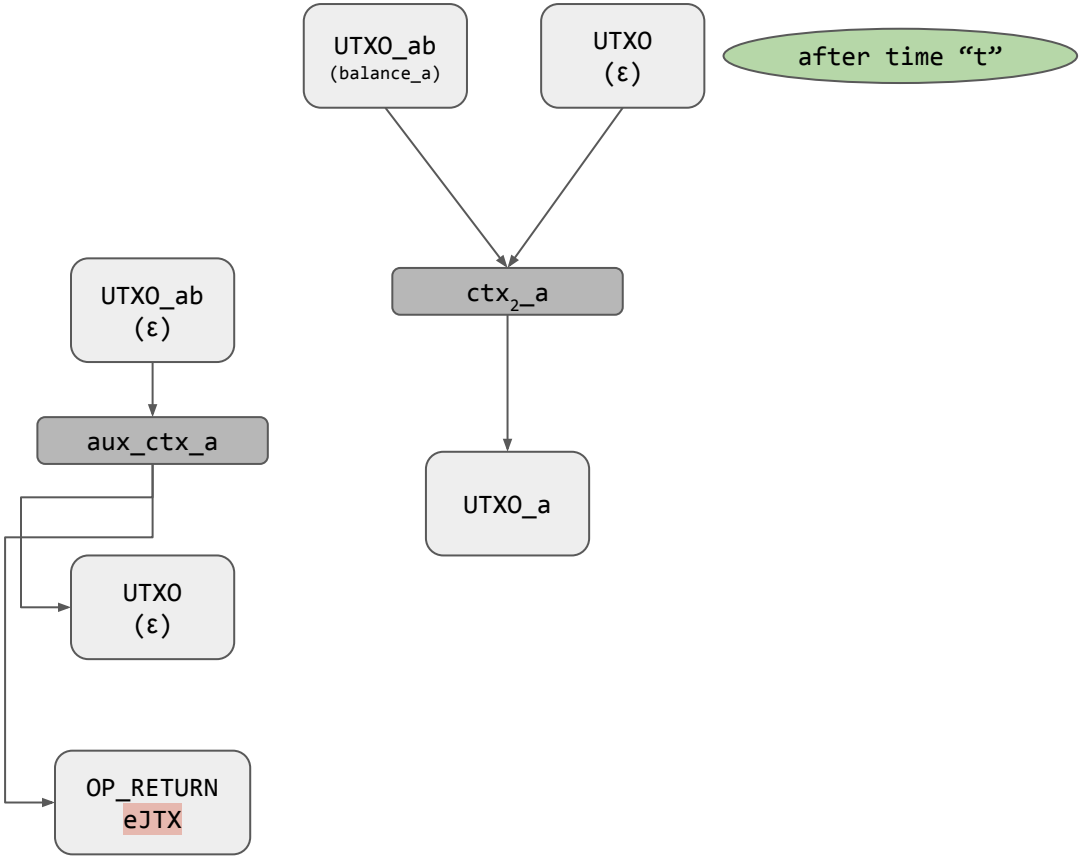


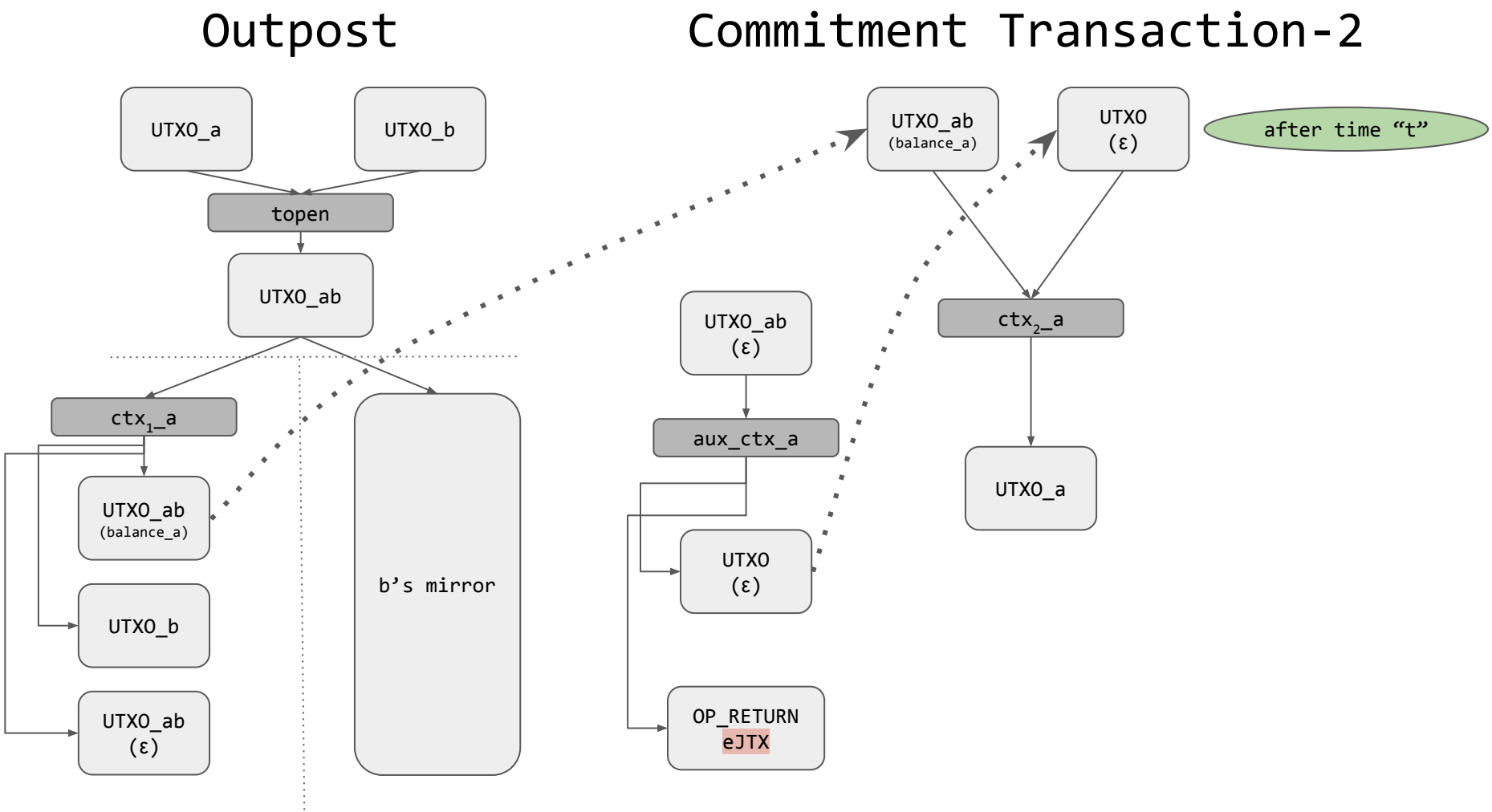

Outpost
Auxiliary Transaction
UTXO_a
UTXO_b
topen
UTXO_ab
ctx1_a
UTXO_ab
(balance_a)
UTXO_b
UTXO_ab
(ε)
b's mirror
UTXO_ab
(ε)
aux_ctx_a
UTXO
(ε)
OP_RETURN
eJTX

Outpost



Commitment Transaction-2




Outpost
Commitment Transaction-2
UTXO_a
UTXO_b
topen
UTXO_ab
ctx1_a
UTXO_ab
(balance_a)
UTXO_b
UTXO_ab
(ε)
b's mirror
UTXO_ab
(balance_a)
UTXO
(ε)
after time "t"
UTXO_ab
(ε)
ctx2_a
aux_ctx_a
UTXO_a
UTXO
(ε)
OP_RETURN
eJTX

Outpost keeps Lightning’s key features

- Unilateral closure: broadcaster has to wait
    - Not cheating
    - Cheating

- Exchange revocation keys vs. AES-128 decryption keys

Cheating (Alice wants to profit)

Time

Alice broadcasts older ctx_1, aux_ctx	Bob is watching the blockchain
Wait	Bob sees aux_ctx
Wait	Bob has key to decrypt eJTX & get JTX_b
Wait	Bob broadcasts JTX_b
Wait	JTX_b is confirmed on the blockchain 😎
Wait	ctx_2 is now invalid
Alice can broadcast ctx_2 - but…	

Unilateral Closure(Bob has disappeared)

Time

Alice broadcasts latest ctx_1, aux_ctx	Bob is secretly watching the blockchain
Wait	Bob sees aux_ctx
Wait	Bob cannot decrypt eJTX
Wait	ctx_2 is still valid
Alice can broadcast ctx_2 - 😎	

Griefing ¯_(ツ)_/¯

Alice broadcasts ctx_1	Bob is watching the blockchain
Wait	Bob sees ctx_1_a confirmed
Wait	Bob's own ctx_1_b is now invalid 😡
Wait	??????
Gone...	

Can we have ctx_1 send all its balance to Bob?

Profit

Outpost

- CTX and eJTX on the blockchain
- eJTX’s key in the node (16 bytes)

Classic Lightning

- CTX on the blockchain
- JTX in the node (~350 bytes)

Cost

Outpost

- 3 txns
- ε

Classic Lightning

- 1 txn
- No ε

Limitations

- OP_RETURN limited to 80 bytes.
    - IsStandard ಠ_ಠ
    - Split aux_ctx into 2; P2SH Data-hash across them

- Bloat
    - Not on the blockchain (happy case)

Optimize!!

SHACHAIN

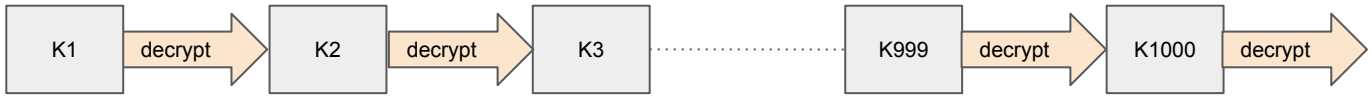
Pre-compute

Use*

RSA-CHAIN

Pre-compute No

Use*



*Key derivation function

Size estimates

Classic Lightning

		20k channels, 1M updates
Known Channel	N·size(ejtx) + 1·size(txid)	7.00 TB
Unknown Channel	N·size(ejtx) + N·size(txid))	7.65 TB

Outpost

Known Channel	size(key) + size(txid)	0.96 MB (WTF)
Unknown Channel	N·size(key) + N·size(txid)	0.96 TB

Note: size(key) << size(ejtx) i.e. 16 << 350

Pay per update

- Online
    - Every Bitcoin block

- Proof of storage
    - Merkle Tree of state updates
    - Ask for proof

Thanks

- Store justice transactions in commitment transactions

- Pay per update, and ask for proof

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