RSK

SMARTER BITCOIN

A Drivechain BIP
enabling the OP_COUNT_ACKS opcode to add Bitcoin drivechain capabilities as a soft-fork.

BUILDING ON BITCOIN

Conference

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SMARTER BITCOIN

Coinspect

CoinFabrik

wayniloans

Code	Product	Description
2012	Bitcoin Core	Lack of orphan tx limit prior v0.5.3
CVE-2012-3789	Bitcoin Core	Multiple DoS Vulnerabilties in Satoshi client
CVE-2012-4683	Bitcoin Core	Targeted DoS by CPU exhaustion using alerts
CVE-2012-4684	Bitcoin Core	Network-wide DoS using malleable signatures in alerts
CVE-2013-2272	Bitcoin Core	Remote discovery of node's wallet addresses
CVE-2013-2292	Bitcoin Protocol	A transaction that takes 3 minutes to verify using O(n^2) hashing
CVE-2013-2293	Bitcoin Core	Continuous hard disk seek
2014	BitcoinJ	Security vulnerability in BouncyCastle ECDSA (BJB-22)
2014	Ethereum/Bitcoin	Unhandled point-at-infinity in public key recovery
2016	Bitcoin protocol	A Bitcoin transaction that takes at least 5 hours to verify
2016	Ethereum	Uncle Mining, an Ethereum Consensus Protocol Flaw
CVE-2017-12842	Bitcoin protocol	Leaf-Node weakness in Bitcoin Merkle Tree Design

Bitcoin & Radical Innovation

Where the new transactions go?

- Overlay protocols
- Extension blocks

Preserve the 10 minute block interval
Increases block size in the same network

- Parallel blockchains
  (now generically called sidechains)

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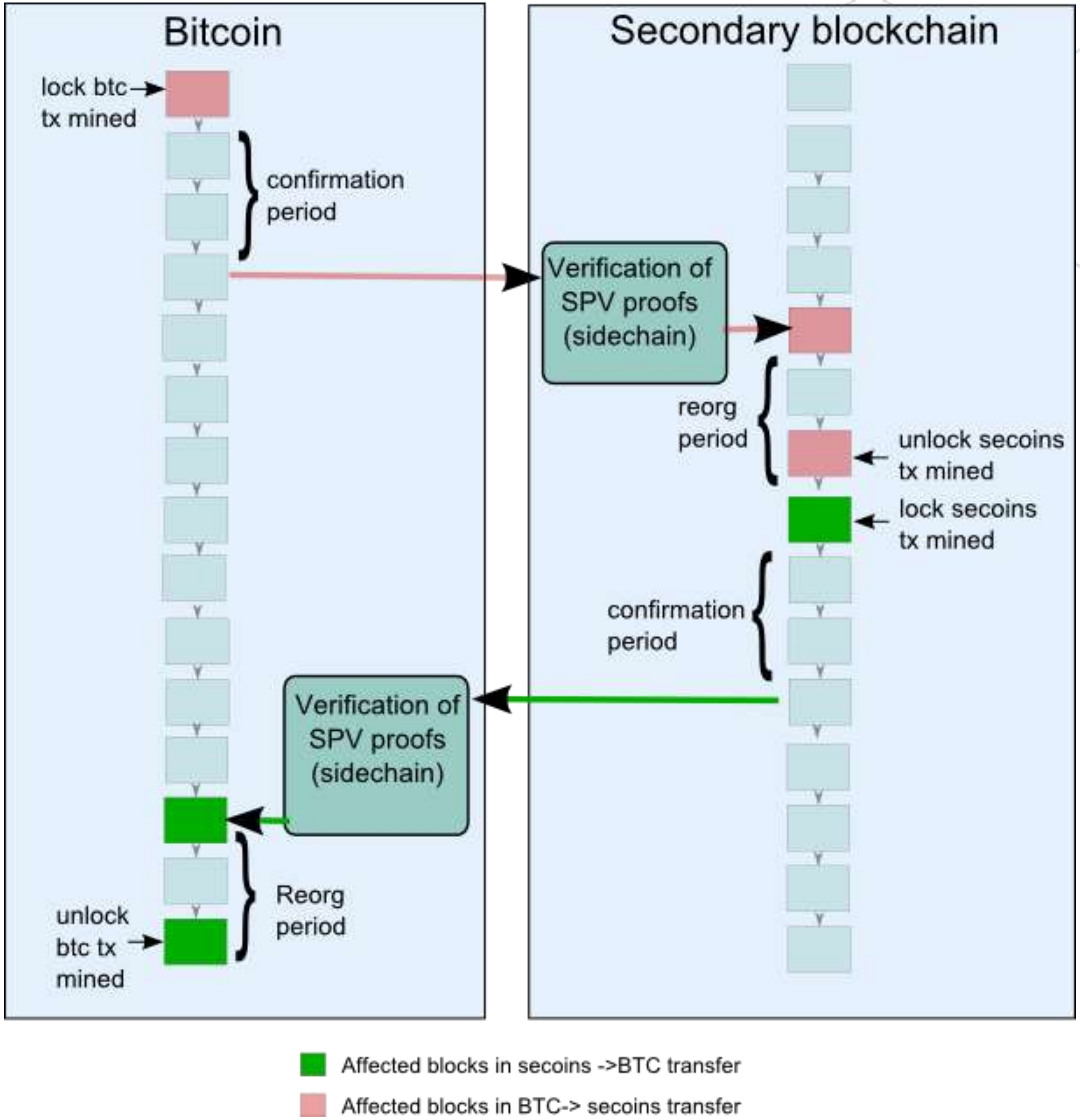
Sidechains: who controls the locked funds?

- Consensus-enforced (original SPV sidechains)
- Federation
- Miners (drivechains/Hashrate Escrow)
- Hybrids

RSK blockchain

- Uses Smart Bitcoin as its native currency
- Provides stateful smart-contracts and 15-secs block times.
- 21% of Bitcoin’s hashing rate (in merge-mining)
- 2-way (1:1) peg with global federation
- Soon to deploy custom and auditable HSMs for federators
- 2-way peg controlled by smart-contract
- Next release: intelligent HSMs that validate PoW, real-world delays and generate time-locked transactions with covenants.

SPV Sidechain



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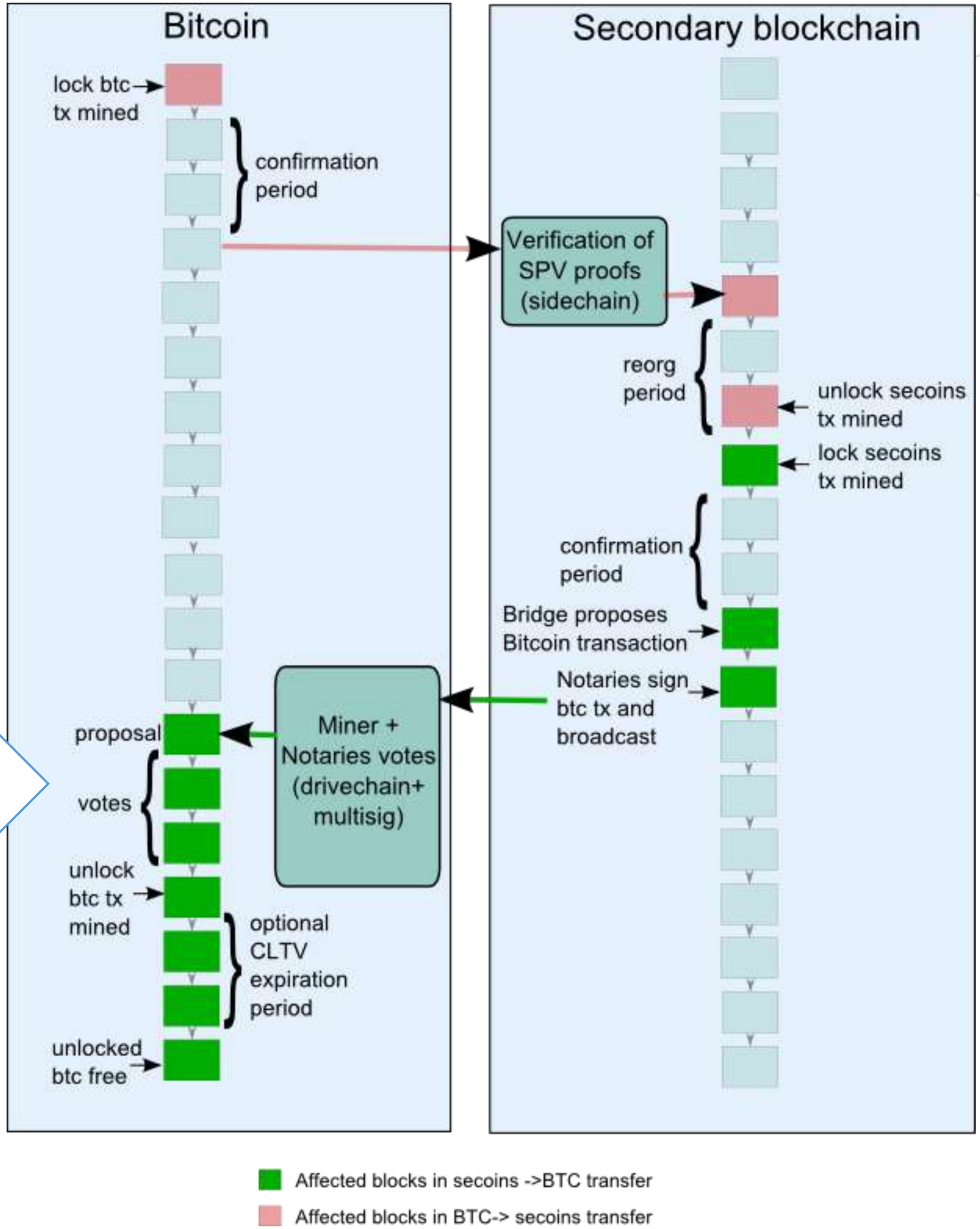
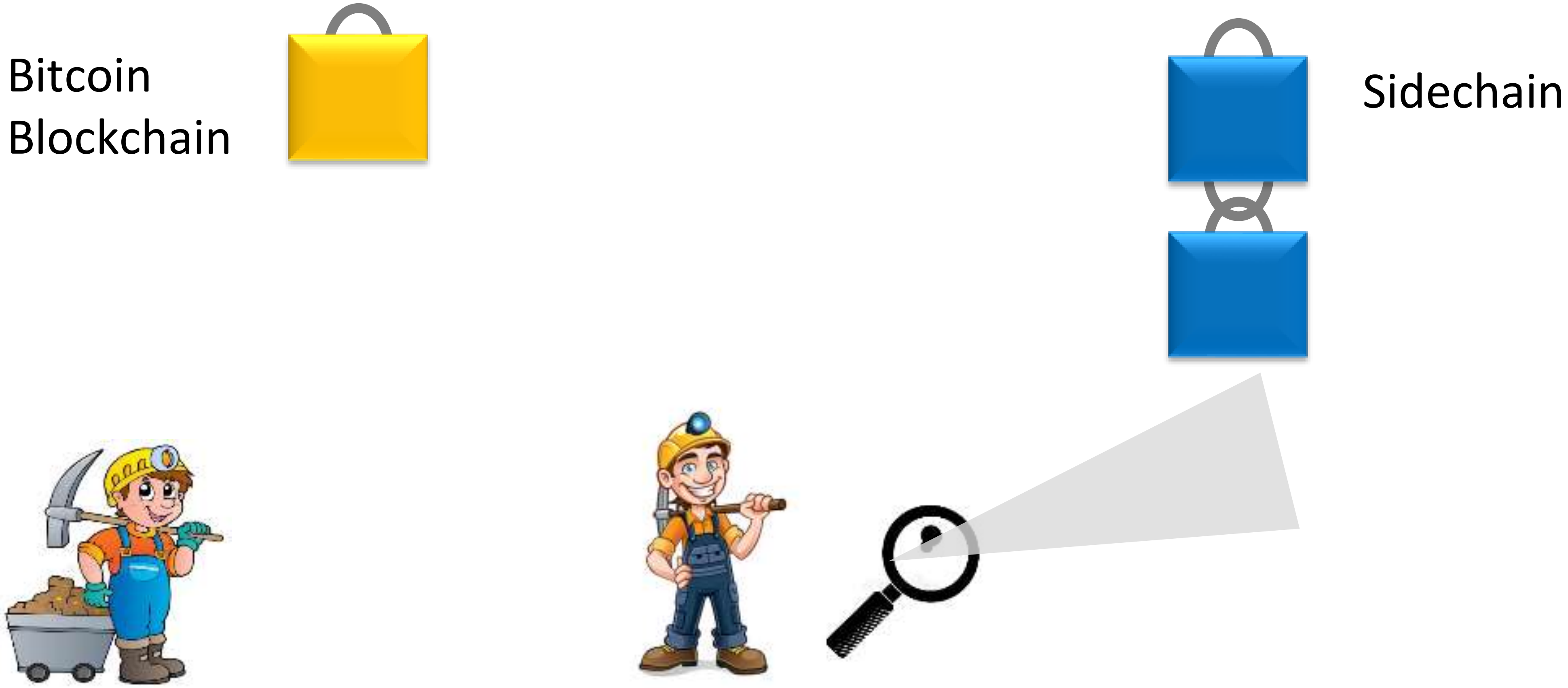
The RSK Case

CountAcks Drivechain in the future?



Bitcoin
lock btc tx mined
confirmation period
proposal
votes
unlock btc tx mined
optional CLTV expiration period
unlocked btc free
Secondary blockchain
Verification of SPV proofs (sidechain)
reorg period
unlock secoins tx mined
lock secoins tx mined
confirmation period
Bridge proposes Bitcoin transaction
Notaries sign btc tx and broadcast
Miner + Notaries votes (drivechain+ multisig)
🟩 Affected blocks in secoins ->BTC transfer
🟥 Affected blocks in BTC-> secoins transfer

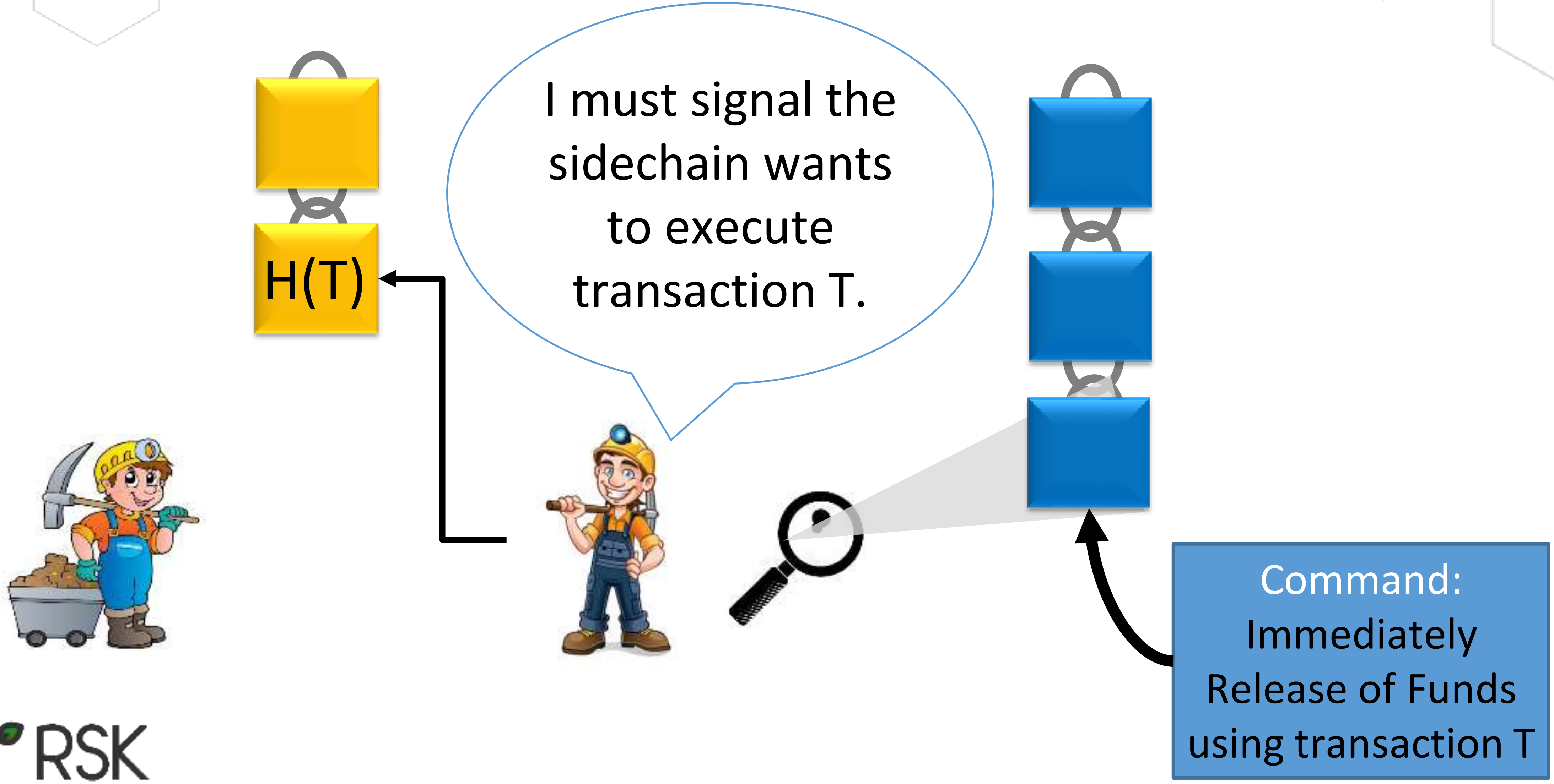
Drivechain / Hashrate Escrow



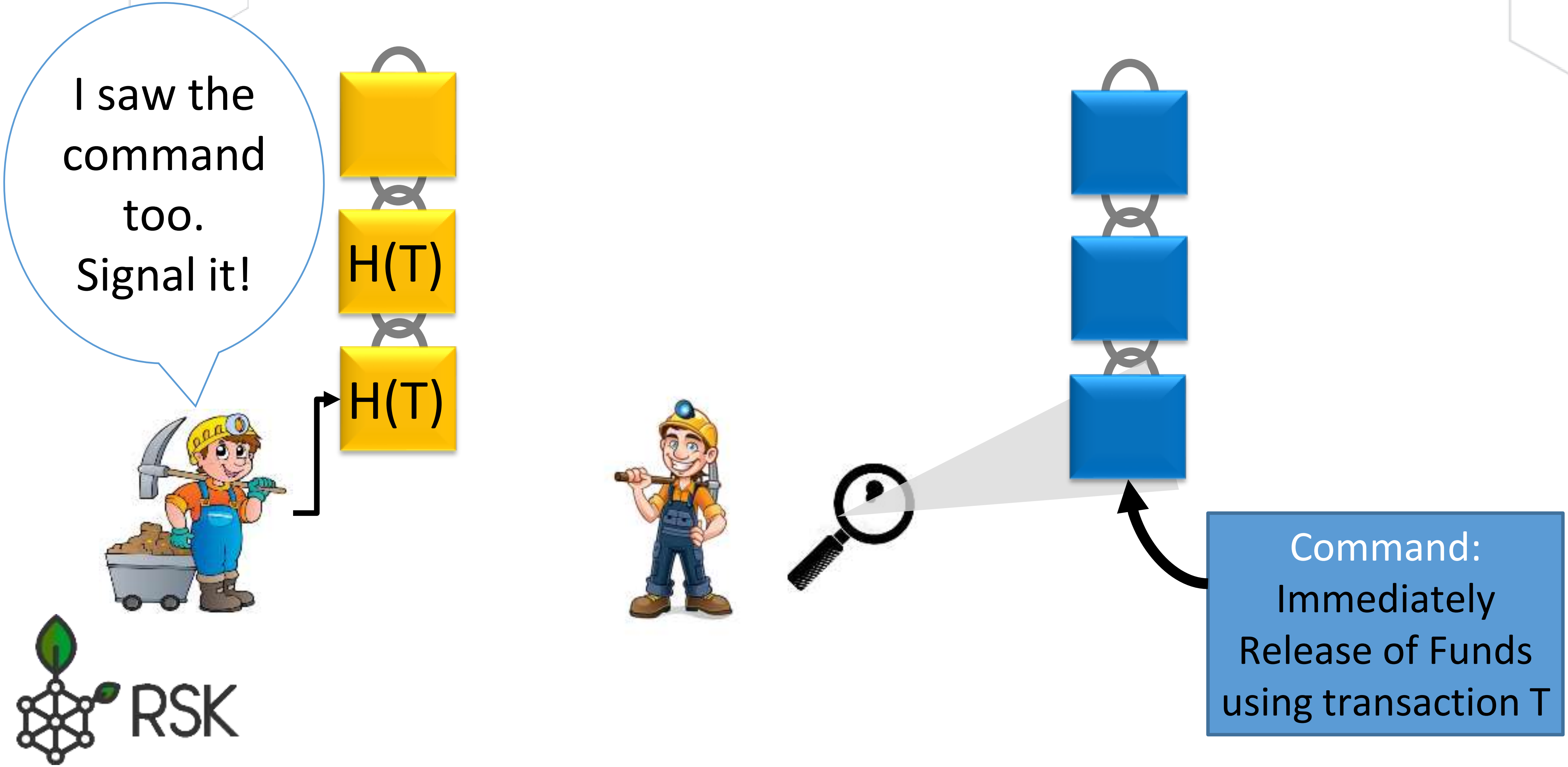
Bitcoin Blockchain

Sidechain

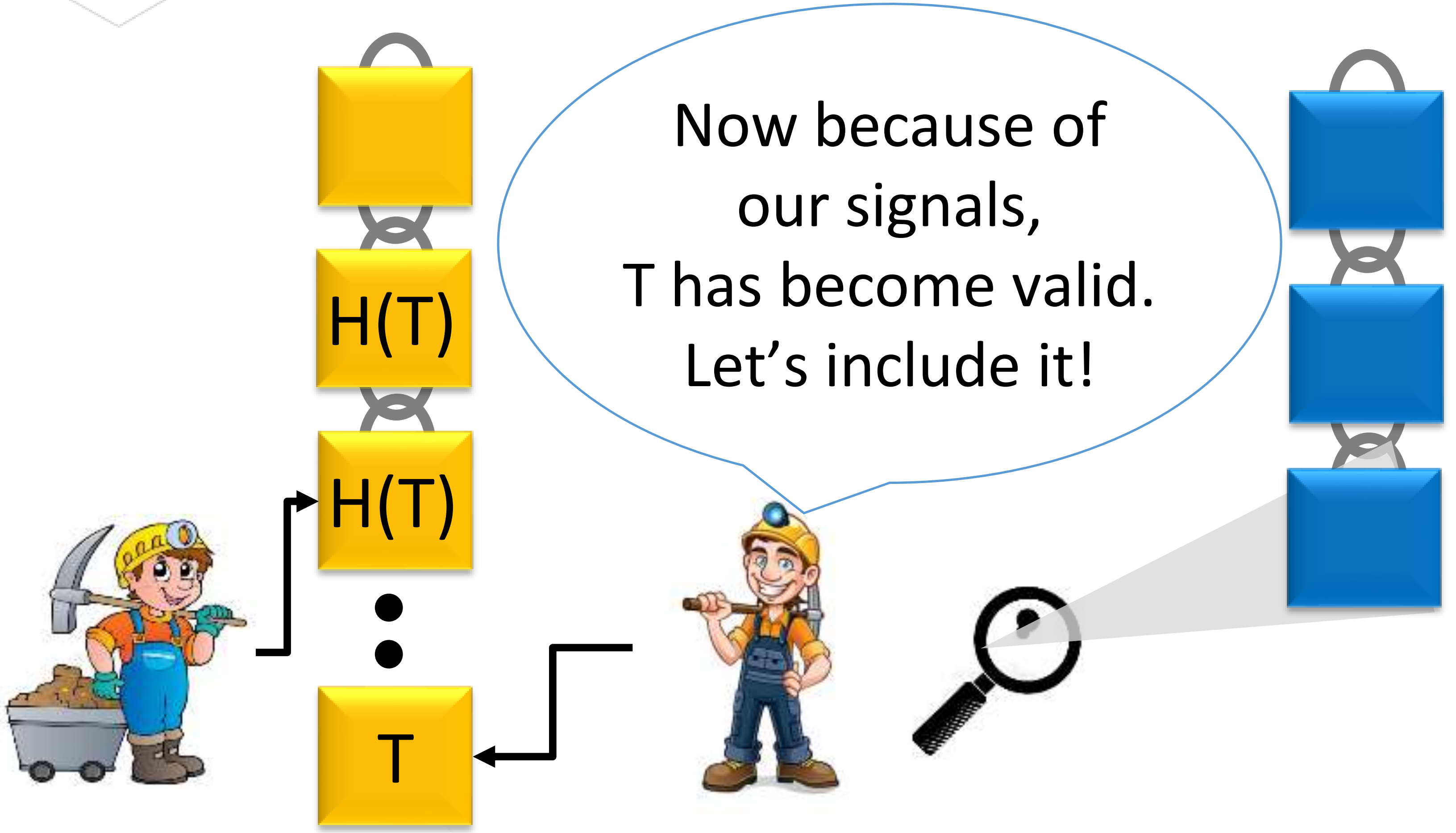
Drivechain / Hashrate Escrow


H(T)
I must signal the sidechain wants to execute transaction T.
Command: Immediately Release of Funds using transaction T

Drivechain / Hashrate Escrow

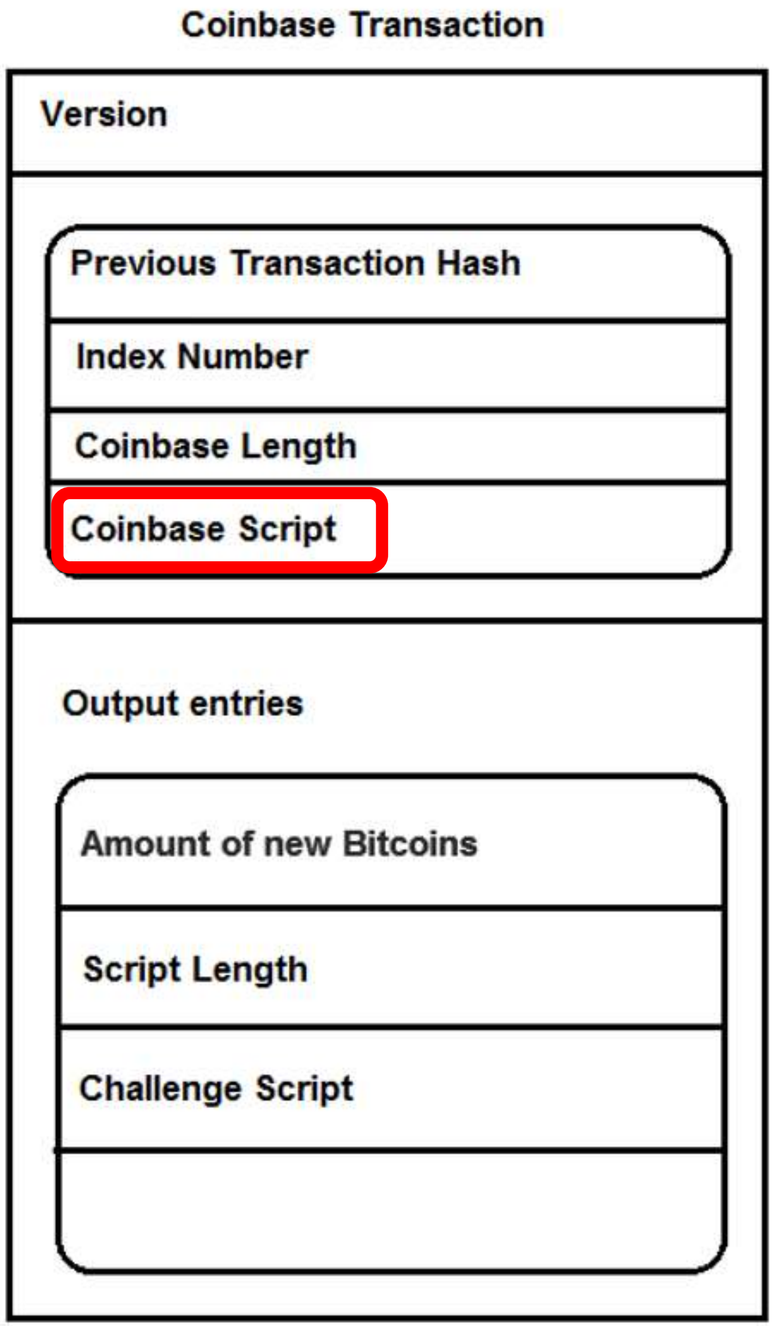

I saw the command too. Signal it!
H(T)
H(T)
Command: Immediately Release of Funds using transaction T

Drivechain / Hashrate Escrow


H(T)
H(T)
T
Now because of our signals, T has become valid. Let’s include it!

ACKs and NACKs

- "ACK:" following FULL_ACK_LIST
- FULL_ACK_LIST: { CHAIN_ACK_LIST... }
- CHAIN_ACK_LIST: { sidechain_id ACK_LIST }
- ACK_LIST: { ACK... }
- ACK: { tx_hash_prefix [tx_hash_preimage] }
- {} = empty list



ACKs and NACKs

- ACK: { { XNET { {} 0x101010....10 } } }   Proposal and ack in XNET

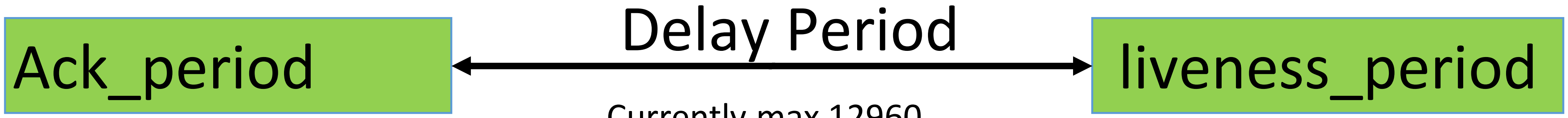
h(0x10....10)=0xbaa501b37267c06d8d20f316622f90a3e343e9e730771f2ce2e314b794e31853)

- ACK: { { XNET { {0xba} } } }   2nd positive ack for the proposal
- ACK: { { XNET {} } }   negative ack for all proposals in XNET
- ACK: { {XNET {} } { YNET { {0x3e9e7307} } } }   Mix for 2 sidechains

- Note: serialization is binary, not ASCII.

OP_COUNT_ACKS

- The opcode has the following arguments:
  - Poll_start_blocknum
  - sidechain_id
  - ack_period (in blocks)
  - delay_period (in blocks)
  - liveness_period (in blocks)



Ack_period

Delay Period

liveness_period

Currently max 288

Currently max 12960

Min 100 blocks

Currently max 288

OP_COUNT_ACKS

- The opcode results:
  - ACK count
  - NACK count

Currently max 288

Sample ScriptPub / Scriptsig (no P2SH / P2WSH)

ScriptSig: 521000

ScriptPub:

```
58 4e 45 54         // ("XNET")
144
1440
144
OP_COUNT_ACKS       // Push Results
OP_2DUP             // duplicate ack counts
OP_GREATERTHAN      // more positive than negative acks ?
OP_VERIFY           // abort if not
OP_SUB              // compute positive minus negative, push result into stack
72                  // difference (positive-negative) acks required
OP_GREATERTHAN      // More than 50% positive difference, put 1 on stack, else put 0
```

Sample script: Drivechain + 2 notaries

- ScriptPub:

0 OP_TOALTSTACK

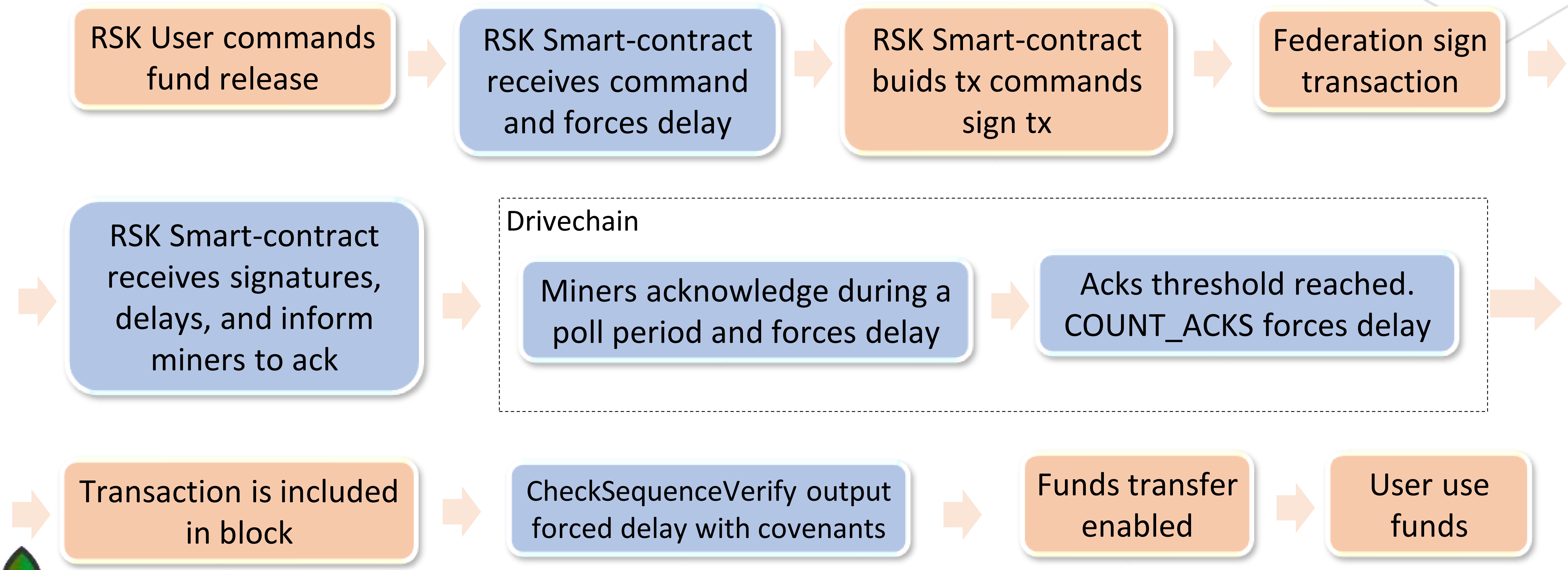
OP_IF <pubkey1>
OP_FROMALTSTACK OP_ADD
OP_TOALTSTACK OP_ENDIF

OP_IF <pubkey2>
OP_FROMALTSTACK OP_ADD
OP_TOALTSTACK OP_ENDIF

58434f494e 144 144
OP_COUNT_ACKS OP_SWAP
OP_FROMALTSTACK OP_ADD
OP_DUP OP_ADD OP_DUP OP_ADD
OP_DUP OP_ADD OP_ADD
OP_SWAP OP_2DUP
OP_GREATERTHAN OP_VERIFY
OP_SUB 72 OP_GREATERTHAN

- ScriptSig: 1 <Signature1> 1 <Signature2> 500000
- Condition: x=(4 * sig + acks), then (x > naks) and (x-naks > 72)

Mandatory Delays & Chances to Revert in RSK



RSK User commands fund release

RSK Smart-contract receives command and forces delay

RSK Smart-contract buids tx commands sign tx

Federation sign transaction

RSK Smart-contract receives signatures, delays, and inform miners to ack

Drivechain

Miners acknowledge during a poll period and forces delay

Acks threshold reached. COUNT_ACKS forces delay

Transaction is included in block

CheckSequenceVerify output forced delay with covenants

Funds transfer enabled

User use funds

CountAcks Design Rationale

- Lightweight soft-fork
- Interoperability with scripting system
- Zero risk of invalidating a block
- No additional computation during blockchain management and re-org.
- Incentive compatible: sidechain pays for withdrawal cost
- No inherent change in Bitcoin security model
- Bounded computation of poll results (2 sigops cost)
- Strong protection from DoS attacks
- Minimum block space consumption (800 bytes per withdrawal typical)
- Zero risk of cross-secondary chain invalidation
- Time for proactive and reactive measures (up to 90 days)

Comparison between CountAcks BIP and Hashrate Escrows BIP memory use

Property	CountAcks	Hashrate Escrows
Lines of code	~600	~4000
Initial sidechain registration (in DB)	0	125 Kbytes
Withdrawal (max blockchain space)	3 Kbytes	157 Kbytes
Withdrawal (avg blockchain space)	864 bytes	157 Kbytes

Sources:
https://github.com/drivechain-project/docs/blob/master/bip1-hashrate-escrow.md
https://github.com/rsksmart/bips/blob/master/BIP-R11.md

New BIP and reference implementation

https://github.com/rsksmart/bips/blob/master/BIP-R11.md

https://github.com/rootstock/bitcoin/tree/op-count-acks_devel

Summary

- Bitcoin federated sidechains have risks of federators stealing the locked funds

- Adding a CountAcks drivechain layer miners prevent federators malicious activity

- You can use also use a pure CountAcks sidechain.

Interoperability

- COUNT_ACKS opcode allow the combination of a drivechain with any other feature of the scripting system.
- Allows to bootstrap a merged-mining two-way pegged cryptocurrency from an initial state when is has no merge-mining engagement to a state where it has a high merge-mining engagement, using notary signatures during the initial period.
- scriptPub can be parametrized for any combination

Zero risk of block invalidation

- The opcode and miner's ack-ing algorithm was designed such that acks in the coinbase field can never invalidate a block.
- This prevents attacks against pools from malicious or faulty proxy consensus observer plug-ins
- Reduces the risk for miners not implementing the soft-fork of extending a soft-forked block that is invalid because of the coinbase tag.

Minimum Computation and Incentive compatibility

- No blockchain computation overhead if there is no sidechain activity
- Sidechain pays for every cycle of computation

Bitcoin security model

- poll liveness period to be equal or higher than 100 blocks, to respect the same maturity rule as coinbases (enables urgent community hard-forks)
- Any blockchain that uses the bitcoin unit of account and holds a high amount of bitcoins could affect the security of Bitcoin.
- Also merge-mining can modify the incentives of Bitcoin miners, and those incentives should be analyzed.

Time for proactive and reactive measures

- 2 days max for polls allow humans to detect corrupted or hacked miners and warn to stop acknowledge process.
- 30 days before transaction becomes valid prevents from massive dishonest miners behavior.
- 2 days of liveness enables publication even if miners interest decrease significantly.

Bounded computation of poll results

- The liveness period and ack period have maximum values (currently 4320 blocks, or one month).
- Benefits:
  - sets a bound to opcode running time
  - is compatible with blockchain pruning
- Still to cache one months of tags requires 1.3 Mbytes top

Strong protection from DoS attacks

- Polls created for unknown sidechains can be safely ignored by miners.
- Unknown or fake transaction candidates do interfere with honest candidates and are automatically negatively acknowledged.

Minimum block space consumption

- Transaction id prefixes for candidates could reduce space in average to 2 bytes per ACK.
- Pre-image publication prevents prefix collusion to force miners to use full ids.
- For example, if 100% of the miners acknowledge a proposal for 100 blocks then the space consumption would be ~ 234 bytes/proposal.
- Cloinbase space allows 12 sidechains making 4 withdrawals per day each (or one sidechain making 50).

Zero risk of cross-sidechain invalidation

- Sizes in bytes.
- Easy skip if inner tag is malformed.
- Miner may collect sidechain acks in serialized format without risk of interaction.

Security

- The security parameters of a specific sidechain are defined by the sidechain designers.
- Exodus addresses should be pay-to-witness-script-hash (P2WSH) address containing all arguments.
- There COUNT_ACKS opcode cannot be used as a vector to perform a denial-of-service attacks (CPU, memory, disk access)
- Sidechain designers should be able to choose between long pre-inclusion delays or long post-inclusion covenants.

Computational Cost

- The cost of the COUNT_ACKS opcode in terms of sigops is set to 2 (a maximum of 288 blocks are scanned).
- The maximum amount of information that has to be fetched is 12 Kbytes.
- Assumes in-memory cache (maximum 500 Kbytes, typically 3 Kbytes).
- Max cost in hashing of tx_hash_preimage to obtain tx_hash is 1440 hash digests. This is comparable to the cost of 2 signature verifications.

Changes from previous proposal (2016)

- Liveness and poll times incremented from 1 day to 2 days
- Variable delay time added of to 3 months of blocks (before it was 100 blocks)

Blind Merge-mining

- Need High sidechain Tx fees

Protections against 51% dishonest miners using Intelligent HSMs

- On-chain release pre-signals
  - with minimum accumulated difficulty
  - Combined other soft-forks
    - Transactions ids that also derive from block hash using a bit in nVersion (finalID = H(blockHash | originalID)
    - Using conditional to block difficulty (OP_DIFFICULTY opcode)
    - Or transactions that can only be anchored only after certain block (OP_BLOCK_HASH_AT opcode)
    - No need to standardize txs using new opcodes
- Covenants through txs with time-locked txs, and return outputs paths