Blockstream

Bringing New Elements to Bitcoin *with Sidechains*

SF Bitcoin Devs Meetup

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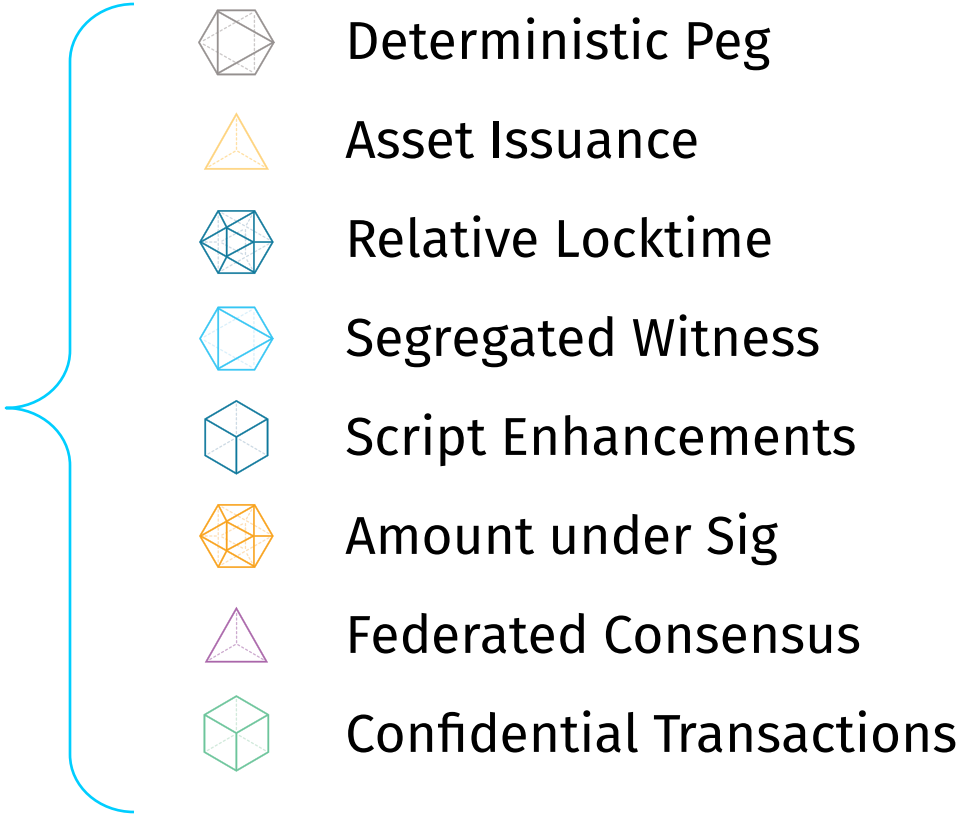
Greg Maxwell

DE47 BC9E 6D2D A6B0 2DC6 10B1 AC85 9362 B041 3BFA

Bringing New Elements to Bitcoin *with Sidechains*

Topics

- Challenges in Advancing Bitcoin Technology
- Introducing Sidechain **Elements**
- Future Directions



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Challenges in Advancing Bitcoin

- Traditional money systems require trust at all levels, this trust is costly to maintain and is unpredictably violated
- Bitcoin's solution
  - Replace most of the trust with a system of mechanically enforceable rules
- Nature protests: a copy of data is as good as the original, information doesn't have “owners”
  - Money needs controlled supply and ownership
  - People are good at ignoring rules (*when they want*)

Challenges in Advancing Bitcoin

Good news:
Bitcoin employs cryptography and economics to deliver system where rules have true force, even against popular will

Bad news:
This created a system where a fixed set of protocols / algorithms were in charge

- If mankind had perfect engineering, perfect foresight, and universal values, it might be okay
- But we don't: mistakes were made, needs change, and people sometimes earnestly have contradictory demands.

Challenges in Advancing Bitcoin

- Some have sought to create new functionality by starting brand new cryptocurrencies
- The value of a money-like good comes from acceptance – it's practically all network effect
- A speculative race around "creating money": bad incentives and no natural stopping point: **foocoin→barcoin→bazcoin→barfcoin**
- The reboot is left with the same problem
- I wish people luck, but I don't think this is a sustainable way to build new technology

Challenges in Advancing Bitcoin

- Bitcoin was designed to embrace new uses with powerful smart contracts and extensibility
- Hobbled by bugs, but it's possible to fix and improve compatibly via soft-forks
  - Previously used to deploy P2SH, the 3- addresses
- It's hard to update a live production system esp. when it was made to be beyond influence
- Most updates are inherently much easier to do in a new network

Advancing Bitcoin with Sidechains

- Bitcoin supports verifying that a payment has happened with very small amounts of communication called SPV
  - There is a security tradeoff with SPV: It trusts miners to verify the history, stronger non-partitioning assumption
- What if a Bitcoin smart contract released coins only according to a Bitcoin SPV proof?
- The result is the “two-way peg” described in the sidechains whitepaper

Advancing Bitcoin with Sidechains

- Two-way peg freezes Bitcoins so they can only be released according to a decision by some other network
- Then they can be brought back
- Gain the freedom and agility of multiple networks without rebooting the network effect
- Put the new, risky, experimental, only-liked-by-a-few features in their own networks
- There are a lot of details to get right to make this work in a usable way

Introducing Sidechain Elements

- Project to advance the art for Bitcoin
  - “No holds barred”, exploratory technology
- With a testnet federated-peg sidechain: Alpha
  - Free Software to open new avenues for everyone
  - With many new and interesting features (elements)
  - But currently without a lot of quality assurance

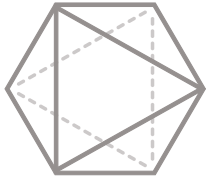
It's nice to work on something without a billion-dollar economy immediately resting on it, but still have a path to production use (and not just production use in competing cryptocurrencies!)

Sidechain Elements

- Each feature in elements right now is someone's experiment
  - Though usually a few people contributed review and other assistance
- We hope that other people will find this software and approach interesting and contribute their own experiments
- I would strongly recommend against using the current code with a real with-value cryptocurrency network

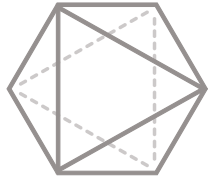
Sidechain **Elements**

Deterministic Peg



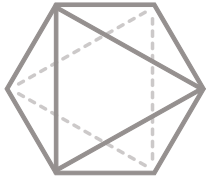
- Implementation of the two-way peg mechanism from the sidechains whitepaper
  - Allows testnet coins to be logically moved to the elements network and back again
- After 10 confirmations in testnet a move to the sidechain can be started on the sidechain side
- Funds held for 144 confirms on the sidechain, which allows someone else to prove that a longer testnet fork exists
- Fundamental insecurity of testnet is limiting here

Deterministic Peg



- “But Testnet script can't parse the return proof!”
  - Uses the Appendix A “federated peg”: a federation of oracles execute the code testnet would run (but doesn’t know how to)
  - Centralized “protocol adapter” absent native support
- Federation is an N of M threshold, plain multisig to testnet
- Participants have no discretion, and the sidechain users can mechanically detect misbehavior
- If N are compromised they can steal coins

Deterministic Peg



- Hybrid model, the other testnet → sidechain direction is verified by the sidechain
- Testnet doesn't have the commitments needed for Appendix B efficient SPV proofs
  - Could put all the testnet headers in the sidechain,
  - Instead nodes verify all they can and then RPC to a local testnet node to test chain membership

Why Issued Assets?

- Bitcoin brought us smart contracts which are enforced trustlessly by the network
- You can imagine using it to build trustless exchange, derivative assets, etc.
- But the network can only control things directly inside it*
- Building fancy synthetic assets out of smart contracts requires the network see the component assets
  - e.g., “Can be redeemed to claim one car or f(date) bitcoins”

Why Issued Assets?

- “Colored coins” have existed for years but...
  - not SPV compatible, users must trace to find the coloring; especially painful for smart property
  - Tons of tiny dusty UTXO on the network, can't have a different retention policy
  - Invisible to the colorblind network, smart contracts can’t be made asset aware; “I'll trade 1 bitcoin for 1 foo”
  - Though, they *could* have strong censorship resistance

Issued Assets

- Tag all coins in the network with an “asset type”
  - Immediately fixes SPV
- All accounting rules are grouped by asset type
  - e.g., sum of inputs of a type have to equal the sum of outputs of that type
- Assets issued via a new special transaction, the txid becomes the asset tag

Why (relative) check-locktime?

- Bitcoin transactions have a 'good after' date
- Many fancy contract examples need refund on timeout to prevent holdup
  - Effectively need a pubkey of A or B and Time>X
  - Add a scriptPubkey rule to check the good-after
- Relative: don't expire based on a fixed clock, instead an initial transaction starts the clock
- Absolute checklocktime (BIP65) may be available on mainnet this year

Relative check-locktime

- In Bitcoin there is a 32-bit sequence per input, increment to indicate updated transactions
- No* consensus rules in Bitcoin currently
- Insecure: miners can happily take an earlier version, no protocol rule stops them
- Soft-fork so that max-1 can spend inputs one block old or older, max-2 two blocks etc.
- Locktime relative to inputs, and sequence numbers now work with protocol enforcement

Why Segregated Witness?

- A Bitcoin can be spent if some input is provided which makes its assigned script returned true
- Network runs the script with the inputs to verify
- What happens if you can take a true script and modify it and get another one? “Malleability”!
  - Third parties can change transaction IDs
  - Potentially breaks multi-step contracts, or even just spending an unconfirmed transaction
  - This is virtually always true, making even boring scriptPubkeys non-malleable is hard (BIP62 tries)

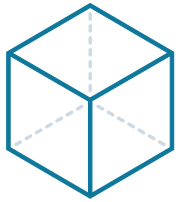
Why Segregated Witness?

- A witness is a specific value that constitutes a concrete proof for an existential claim
- Bitcoin doesn't care *why* the scriptPubkey accepted, just that it does
- Fancy crypto can make it possible to skip sending the witnesses entirely – but not practical yet
- If you're not verifying the history, instead trusting it blindly, you don't care about the witnesses, but they are 2/3 of the data.
  - But you have to fetch it to verify transaction hashes

Segregated Witness

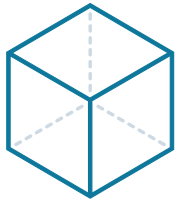
- Change to the transaction hashing structure
- Logically splits the transaction into two parts:
  - Witness (the scriptSig fields)
  - The transaction (everything else) ⬅ TXID only covers this
- Blocks still commit to the witness:
  - H(H(tx) || H(witness)) in the transaction tree
- Syncing the block chain without signature checks can skip witnesses, and unwanted third-party changes are prevented

Why Script Enhancements?



- Bitcoin Script was once much more powerful
  - A bit *too* powerful: crash nodes and steal coins
- Many operations “disabled” – really, removed
- Not technically hard to fix, especially in a hard-fork, but… catch-22: no one uses functionality that isn't there, hard to justify adding things people don't use
- A much more powerful system has been in the works, on and off for some time…
- But if experimentation is cheap, why not?

Script Enhancements

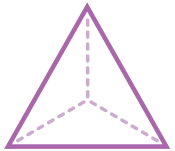


- Re-enabled: concatenate, substring, truncate right/left, shift left/right, bitwise INVERT, AND, OR, and XOR
- Plus some more e.g., a CSPRNG randrange
- Also replaced ECDSA with Schnorr
  - Efficient (non-accountable) multisig
  - Batch verification (2x speedup)
- Check signatures for arbitrary data on the stack
- No more non-verify CHECKSIG operations

Speaking of Signatures...

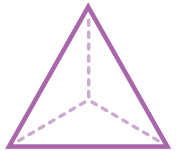
- In Bitcoin signatures only sign the amount of the coin they're spending by signing its txid
- To prove to a hardware wallet what its signing you have to stream all the input transactions to the device
  - Otherwise it can't tell how much it's spending
- In a contrived case you could make this be as much as a gigabyte of data in Bitcoin today
- Just include the amount directly in the signing hash and the transaction is invalid if you lie to the device

Why Federated Consensus?



- Decentralized consensus is essential for upholding the Bitcoin ethos in a public system
- But what does that mean for private systems?
- Is decentralized consensus even possible for experimental, low value, or small systems?
- How can you safely bootstrap mining?
- Lots of other consensus models exist...
- Sidechains paper describes Bitcoin's mining consensus as a dynamic-membership multiparty-signature

Federated Consensus



- Replace mining DMMS with a plain multiparty-signature: Yields a *centralized* security model
- But (arbitrarily) better than “trust one party”
  - Real-time audited by all participants
  - Most dishonest behavior machine decidable
  - Arbitrary multisig policy (A & 5-of-8) | (8-of-8)
- No human discretion required: can implement on tamper-resistant hardware
- Some applications need trust: if you have it, why not use it?

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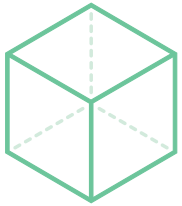
Principal Investigator: Jorge Timón

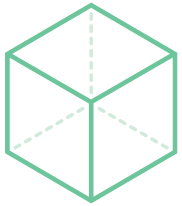
Why Confidential Transactions?



- Traditional transaction systems provide privacy
  - Essential for both commercial and personal use
  - Absent it, thieves can target selectively; negotiating positions undermined; fungibility lost
- Public consensus needs public verification
  - Surprisingly: compatible with complete privacy

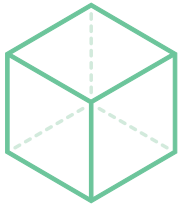
  Consider digital signatures: your secret key is secret, but you prove you know it …

Why Confidential Transactions?



- Bitcoin uses pseudonymity
  - Fragile at best. Paying someone usually leaks your identity *and* financial information, addr reuse leaks it to everyone
- Lack of privacy oft-cited as a concern by *institutions*
- Transparency is a powerful feature, but it cuts both ways if not *controlled* by its users
  - Exacerbates existing power imbalances
  - Besides, raw information isn't *meaningful* transparency
- Yet harmful uses still have privacy, it's just expensive

Why Confidential Transactions?

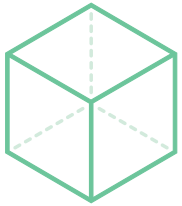


- Many involved long-term in the development of Internet protocols regret that we lack ubiquitous encryption today
- There was always a reason: “It's complex”, “It's slow”, “It’s incompatible” … technically *true*, but mostly insignificant in hindsight. The failure to make crypto default only gets harder to fix

If Bitcoin displaced other systems of money,
would I want to live in that world?

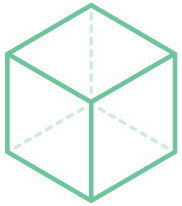
Not without major improvements on this issue

Why Confidential Transactions?



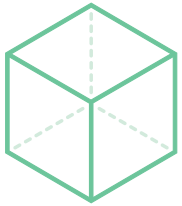
- Past proposals to improve Bitcoin privacy:
  - Compatible: CoinJoin, CoinSwap, centralized servers, ...
  - Cryptographic solutions: Zerocoin, OWAS, Traceable ring signatures (bcn/xmr), Zerocash, ...
- Compatible solutions mostly suffer from loss of privacy due to transaction amount tracing
- So far, cryptographic solutions break pruning and often need new strong assumptions, have very poor performance, and/or just aren't implemented

Confidential Transactions



- Prior work focuses on the transaction graph…
  - What if you make transaction *amounts* private?
- Amounts are usually more important to keep private
- 8-byte amounts become 33-byte commitments – like a hash
- The blinded commitment preserves addition
  - Thus the network can verify that the amounts add up
- Originally proposed by Adam Back in 2013: “bitcoins with homomorphic value” on bitcointalk

Confidential Transactions



- Must prevent negative values when splitting: (1 + 2) = (-10 + 13)
  - needs zero-knowledge range-proof, linear in size
- I invented a generalization of ring signatures and other
- optimizations to make the range proofs more efficient
  - 2.5KB for 32bits: up to 42, 429, 4294, ... BTC depending on exponent
- Then came up with a way to use 80% of their size to communicate a private message to the payee
- Compatible with watching wallets: share a scanning key to allow watching without spending, or share a blinding value to prove a payment amount to anyone

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Principal Investigator: Greg Maxwell

Future Direction

- I'm looking forward to watching alpha network explode in *interesting* ways
  - Testnet itself has been under some interesting attacks lately...
- Continuing refinement of these elements and creating more
- Will the potential to introduce new technology for Bitcoin without seeking permission or rebooting the adoption result in more development beyond ours?
  - I don't know, let's find out together

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Thanks for your time.

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