IT486 v3.0: Blockchains and Cryptocurrencies

Hard and soft forks, Cross-blockchain swaps

Software changes - Hard forks

- Suppose a software change is proposed that will produce blocks that will not be accepted as valid under the old version
- Consider, for example, a change that increases the block size limit from 1 MB to 9 MB
- This is called *hard fork*

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        - continue working on the longest branch which contains only blocks that abide by the old rules
    - upgraded miners will accept the block
- This results in a blockchain fork

Hard fork

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  - one branch containing the 9 MB block and
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  - the other branch containing only blocks that abide by the old rules
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- legacy miners see only the branch not containing the 9 MB block

Case 1

- Assume the legacy miners control the majority of the network hashrate
- Then any branch containing blocks which violate the old size limit will eventually be abandoned by the upgraded miners (why?)

Case 2

- Assume the upgraded miners control the majority of the network hashrate
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Case 2

- Assume the upgraded miners control the majority of the network hashrate
- Then they will abandon the branch not containing the 9 MB block, but this branch will not be abandoned by the legacy miners as it is the only valid branch they see
- The fork remains, with both chains being extended forever

Software changes - Soft forks

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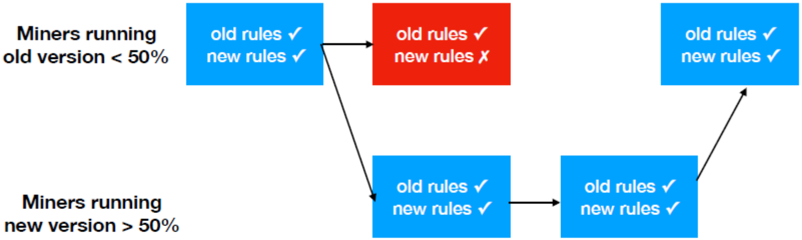
- A software change can be effected by a *soft fork* if it restricts the ruleset enforced by miners
- Consider, for example, a change that decreases the block size limit from 1 MB to 500 KB
- A majority of miners running the new version can outpace the legacy miners, who will accept the longer branch constructed by the miners using the new version
    - there is no risk of two distinct branches emerging when some miners continue to use the old software

Soft fork



Miners running old version < 50%

Miners running new version > 50%

old rules ✓
new rules ✓

old rules ✓
new rules ✗

old rules ✓
new rules ✓

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(red = not accepted by the other camp)

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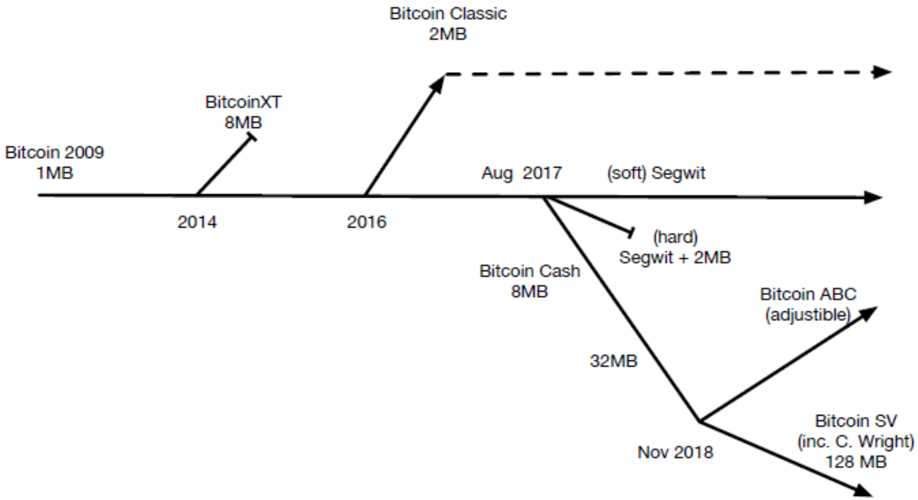
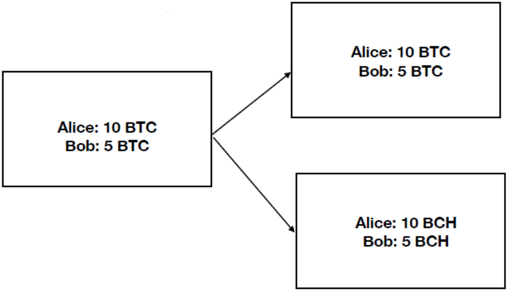
- Argument against:
  - it requires a hard fork, which risks splitting the community

Prominent blocksize-motivated forks



What happens to money in a hard fork?

- In a hard fork, currency holdings split into two distinct holdings on the two branches



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Alice: 10 BCH
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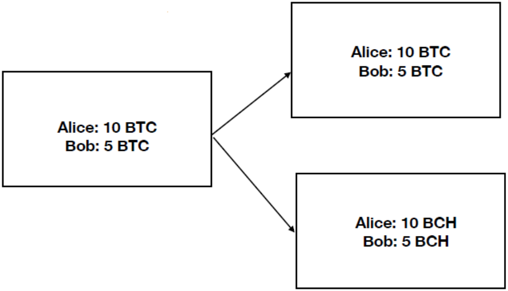

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- when an exchange controls the private key, it may not distribute the forked value to its users
  - sometimes the exchange collects it for itself!

Exchange value of a forked currency holding

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  - holding → original holding + holding on forked chain
  - total value = value(original holding) + value(holding on forked chain)

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    - holding → original holding + holding on forked chain
    - total value = value(original holding) + value(holding on forked chain)
- What is the total value held, in some other currency (e.g. INR)?

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    - fork brings in new capabilities / new users

User response to a hard fork

- Options
  - quickly sell off or spend one of the holdings
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- Options
  - quickly sell off or spend one of the holdings
  - hold both
- Possible reasons for sell off
  - loss of confidence in crypto-currency
  - expecting a drop in value of what you are selling
  - philosophical opposition/support for a chain's ambition/philosophy
  - speculation

Miner response to a fork

- Options
  - Keep working on the chain you were on
  - Switch to the new chain
  - Distribute your mining power across the two chains
  - Switch your mining power back and forth across the two chains

Miner response to a fork

- Reasons
  - You support the philosophy/ambition of one chain more than the other
  - The majority of the users have gravitated to one of the chains
  - The choice is the one that maximises your profit

Network effect

- The value of an application enabling interactions between users derives in large part from the number of users of that application
- Example: Social media
- The same effect applies to cryptocurrencies
    - the currency/blockchain fork with the larger number of users will tend to be more attractive, so win out in the end

Cross-chain Swap

- Alice has Bitcoin, wants Litecoin
- Bob has Litecoin, wants Bitcoin

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- Alice trades Bob 1 Bitcoin 1 BTC for 10 LTC

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  Untrusted:
  - No trusted third party is needed

Is this swap atomic?

- Alice as initiator sends Bob her 1 BTC
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- Note: Bob can cheat Alice, but Alice can't cheat Bob

Atomic Swaps

- What if somehow they could exchange “exactly at the same time”?

Atomic Swaps

- What if somehow they could exchange “exactly at the same time”?
- Create transactions, on both chains
- Add a spending condition, which only can get true on both chains simultaneously (even if chains are totally unrelated)

Step 1: Secret Generation

- Initiator (i.e. Alice) thinks of a random secret S, example:

  correct horse battery staple

- She calculates the hash H of the secret S:

  2259 . . .

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    OR
  - by Alice at some time t_A in future (failsafe refund)

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- This type of Tx is called HTLC: hash-time-locked contract

Step 3: LTC funding Tx

- Bob sends his funds (10 LTC) into a contract Tx (or funding Tx) on the LTC chain, locking the output

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- Bob sends his funds (10 LTC) into a contract Tx (or funding Tx) on the LTC chain, locking the output
- Output (i.e. 10 LTC) can be spent EITHER
  - by Alice if she knows (and provides) the secret S which will hash to the value H
    OR
  - by Bob at some time t_B in future (failsafe refund)

Notes

- What happens if Bob fails to submit his contract Tx?

Notes

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- the output from Alice's contract Tx (1 BTC) will be sent back to Alice at time t_A

Steps 4 and 5: LTC/BTC claim Tx

- Alice claims LTC, revealing her secret S

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- Alice claims LTC, revealing her secret S
- Bob uses S to claim BTC

Notes

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- What happens if Alice fails to claim LTC?
- Output from Bob's contract Tx (10 LTC) will be sent back to Bob at time t_B

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- possibility to somehow time-lock funds
- support the same hashing algorithm in the evaluating script
- branching support in scripts (if / else) to realize failsafe path

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- support the same hashing algorithm in the evaluating script
- branching support in scripts (if / else) to realize failsafe path
- this is true for most Bitcoin-like chains

Secret size attack

Remember, our secret:

correct horse battery staple

which hashes to:

2259cd5b42ae4d70deaa3d8d2ead2bb32ed3677b

- Is there a limit for the maximum possible length of a secret?
- For Bitcoin: maximum number of bytes pushable to the stack is 520 bytes

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- Is there a limit for the maximum possible length of a secret?
- For Bitcoin: maximum number of bytes pushable to the stack is 520 bytes
- When this limit is different between two chains, an attack is possible

Secret key attack

- Imagine evil attacker Eve owns FantasyCoin FC which allows max. 300 bytes-sized script elements
- Eve and Alice agree to trade 10000 FC against 10 BTC
- Eve creates a secret which is $>$ 300 bytes but $<$ 520 bytes long and hashes it

Secret key attack

- Eve proceeds as discussed before (locks her FC into the Funding TX, informs Alice)
- As soon as Alice has locked her 10 Bitcoin in her Funding TX, Eve can claim them (as planned, because she as initiator knows the secret)

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- Eve proceeds as discussed before (locks her FC into the Funding TX, informs Alice)
- As soon as Alice has locked her 10 Bitcoin in her Funding TX, Eve can claim them (as planned, because she as initiator knows the secret)
- But when Alice now wants to claim her 10000 FC in return, she cannot: although she now knows the secret, she cannot use it, as it's too large to be used in a FC coin script