The Future of Bitcoin

Decentralize everything!

The Future of Bitcoin

- The block chain as a vehicle for decentralization
- Routes to block chain integration
- What can we decentralize?
- When is decentralization a good idea?

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Motivating Example: Smart Property

Step 1: car controlled by a cryptographic key

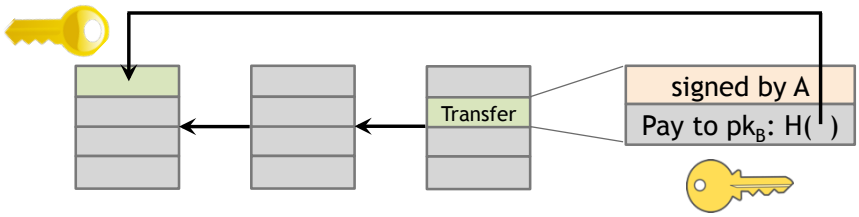
Car has public key hard-coded

Activated upon receiving message signed by corresponding private key

Motivating Example: Smart Property

Step 2: public key is dynamically updated based on Bitcoin block chain

Alice owns the car because she controls private key of green Tx output.

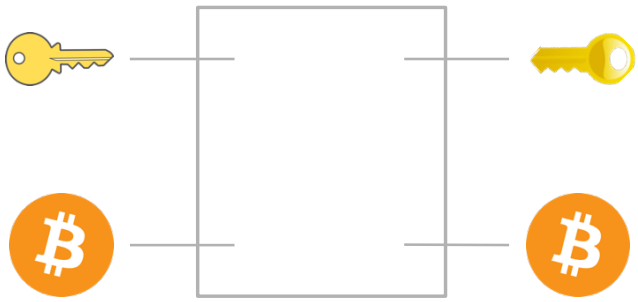


Now Bob's key activates car

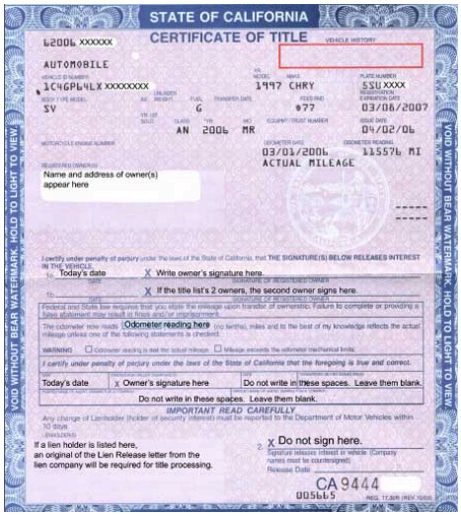
Motivating Example: Smart Property

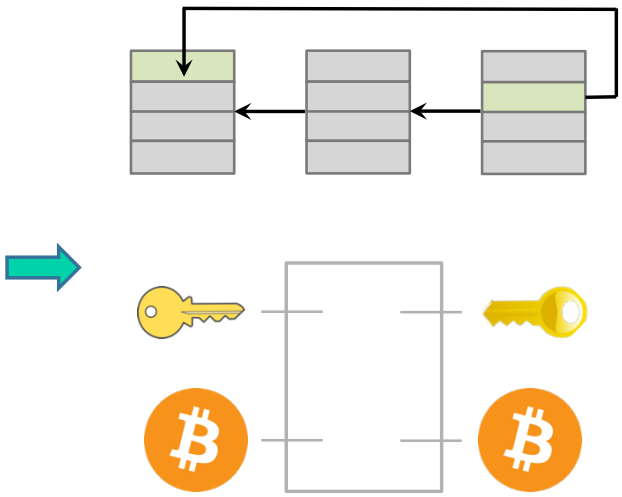
Step 3: Create a single transaction that combines Bob's payment to Alice and Alice's ownership transfer to Bob.

Alice and Bob sign separately, then broadcast.



Decentralized Property Ownership





Representation and Atomicity

Representation:

How to encode complex transactions into the block chain?

Atomicity:

How to couple the actions of the various parties?

Questions

- What else can we decentralize this way?
- Can these be done on Bitcoin or do they require a separate block chain?
- Are there alternatives to atomicity?
- Is it a good idea to do commerce like this?

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Route 1: Directly on Bitcoin

Advantage:

easy to deploy

Disadvantages:

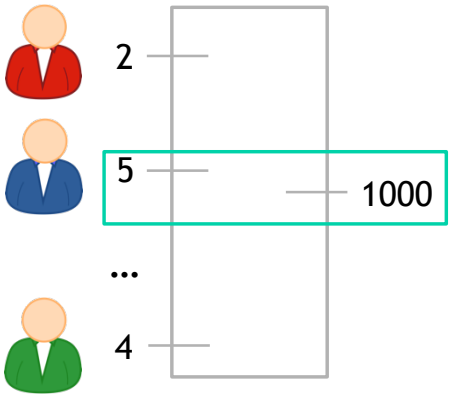
limited representation and atomicity

Example: Crowd Funding

Single Tx with arbitrary number of inputs and 1 output

Spendable only if Σ(inputs) $\geq$ output

Each funder signs only her own input and the output



Example: Pay for Proof

- Alice knows x such that $H(x) = c$
- Bob would like to pay Alice in exchange for x
- Bob's Payment should be atomically coupled with Alice's publication of x on block chain

Possible but unwieldy

Route 2: Embedding

Recall: Colored coins

Similar to representation of car ownership, but relies on entire history

Recall: Mastercoin

Route 2: Embedding

Advantages:

- Complex representations possible
- Security of Bitcoin block chain

Disadvantages:

- Limited scripting and atomicity
- Results in unwanted Tx's in block chain

Route 3: Side Chains

Recall:

merge-mined, 1-1 pegged Bitcoin testbed

Advantage:

Avoids polluting the block chain

Disadvantage:

Requires Bitcoin modifications

Route 4: Altcoins

Example: Ethereum

- General framework for ledger-based consensus
- Turing-complete scripts
- Pay for miner computation using "gas"

Which Approach to use?

Conceptually, any of the four can implement smart property

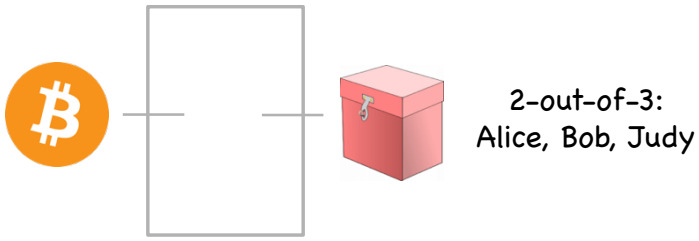
Differences in power and flexibility

Practical differences, e.g: SPV feasibility

Back to the Car Sale Example

What about a dispute?

Recall: 2-out-of-3 escrow



Comparison to Legal Remedy

Advantage(?):

Alice and Bob have freedom to choose mediator Judy

➔ competition between intermediaries

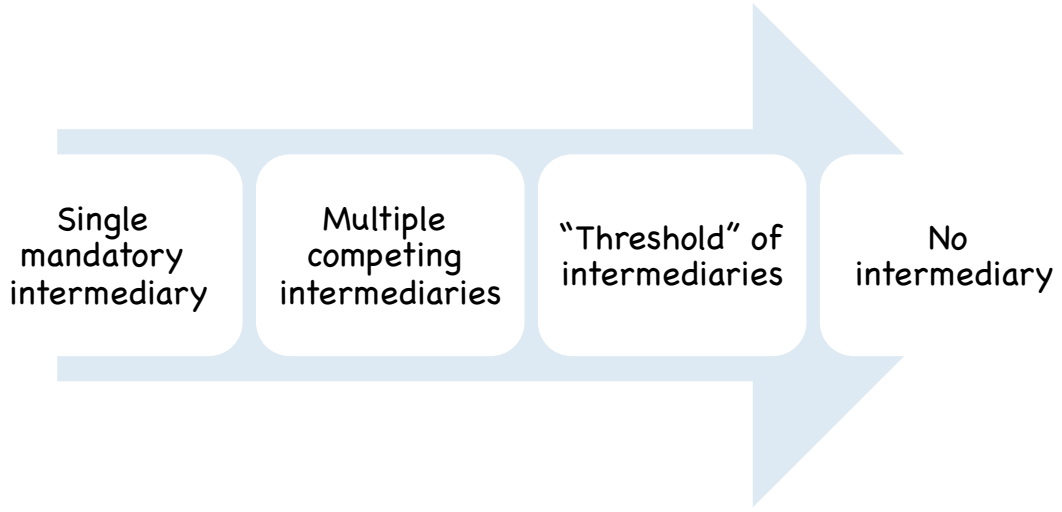
Disadvantage:

Funds tied up during mediation

Competing Intermediaries

Recall: Decentralized prediction market achieved by allowing anyone to start a market.

Levels of (De)centralization



Improving Security

- Reputation
- Escrow & dispute mediation
- Atomic exchange
- Trusted hardware

} Seen so far

Limitations due to lack of real-world enforcement:
no debt or punitive measures

A generic Decentralization Template

- What is being decentralized
- Type of block chain integration
- Level of decentralization
- How security is achieved

Allows succinctly representing almost any proposal for block chain based decentralization

Example: Smart Property

Decentralizes	property ownership and trading
in the sense of	disintermediation
using	Bitcoin
via	atomicity

Example: Decentralized Prediction Markets

Decentralizes	prediction markets
in the sense of	competition
using	an Altcoin
via	atomicity

Example: StorJ

"Agent" that lives in the cloud

Pay to store a file for fixed period (say 1 day)

Has other aspects such as reproduction
(ignore for now)

Example: StorJ

Decentralizes file storage and retrieval
in the sense of competition
using Bitcoin
via reputation

Example: Zerocoin

Decentralizes	mixing
in the sense of	disintermediation
using	an Altcoin
via	atomicity

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1. Purely digital Things

- Name mapping
- Storage
- Pay for proof
- Random number generation
- Lotteries

2. Things that can be represented digitally

- Real-world currencies
- Stocks
- Other assets

3. Property Ownership and Trade

Smart property and atomic exchange

4. Complex Contracts

Crowd funding

Financial derivatives

- Requires price data feed unless underlying asset is traded on block chain

5. Markets and Auctions

Centralized markets:

- Used bike store — buys your bike, sells it later
- EBay — matches participants, routes payments
- PayPal — processes payments, (some) dispute mediation
- Craigslist — matches participants

How to decentralize Markets

Payment	Bitcoin
Transfer of goods	smart property, atomicity
Dispute handling	escrow
Matching participants	??

Decentralized Matching

- Broadcast partially complete transaction to P2P network
- Counterparty finds it, completes, signs, broadcasts

Variant: use block chain instead

Variant: Auction

Counterparty can't complete directly, must return to auction creator

Variant: Double Auction (Order Book)

Both sides simultaneously broadcast partial transactions

Miners match orders, keep bid-ask spread
(Avoids miner front-running)

6. Data Feeds

Recall: Data feeds allow arbiters to assert facts about the world into the block chain.

Examples:

price movements, outcomes of events, ...

Big incentives to lie!

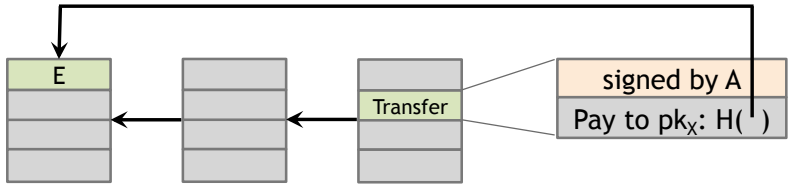
Decentralization by Voting

Centralized version:

Tx corresponds to event E with outcomes X, Y, Z

Transfer to pk_X if outcome X happens

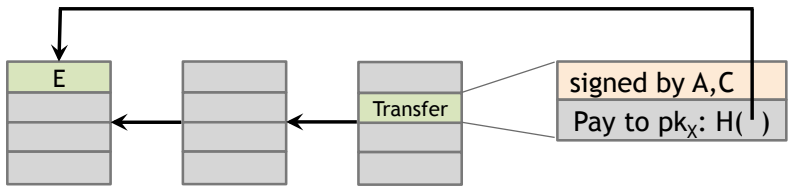
Signed by arbiter A



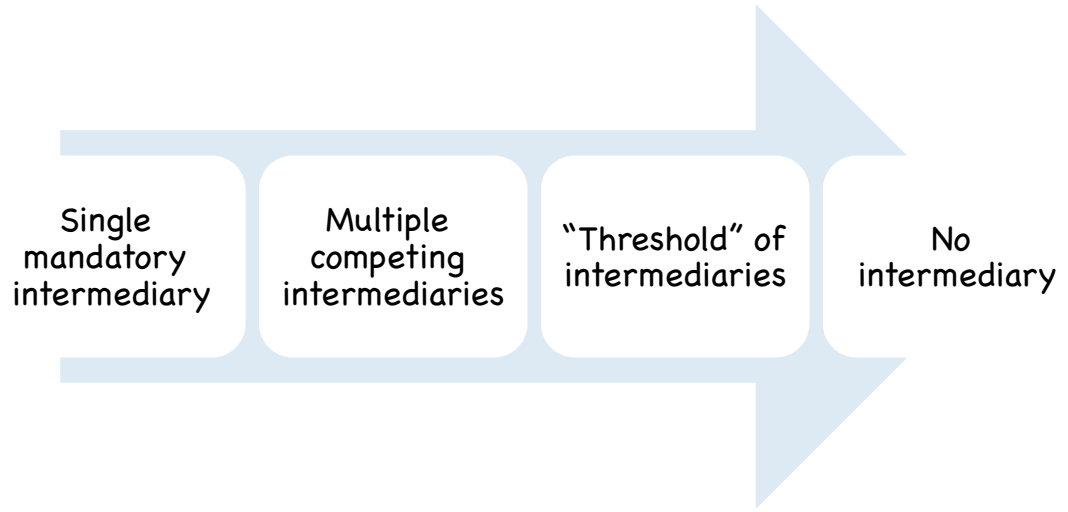
Decentralization by Voting

Decentralized version:

E is a 2-out-of-3 multi-sig address controlled by A, B, C



Levels of (De)centralization



7. Autonomous Agents

Key features

- Contracts
- Data feeds
- Voting as a way to change the rules
- Some variants: reproduction

Challenges

- Keeping private state
- Hostile takeover

Example of DAO: The DAO

- Decentralized Autonomous Organization
- Exists as a set of contracts among people
- Contracts reside on the Ethereum blockchain
- Does not have a physical address, nor people in formal management rules
- Power directly in hands of owners, not directors and fund managers
- Completely transparent: everything done by code, which anyone can see and audit, on GitHub.

Example of DAO: The DAO (2)

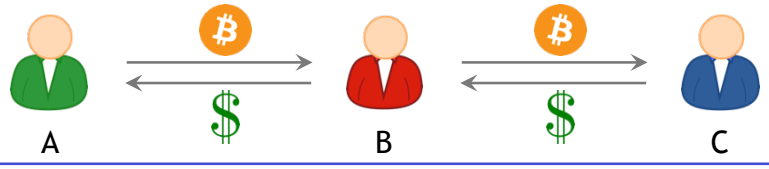
- DAO intended as "a hub that disperses funds to projects".
- Investors receive voting rights by means of a digital share token.
- To interact with real-world legal structures, The DAO established a Swiss-based company, DAO.Link
- Swiss law allows it to "take money from an unknown source as long as you know where it's going."
- June 2016: The DAO subjected to a $50M hack due to a weakness in the code.

8. Exchanges

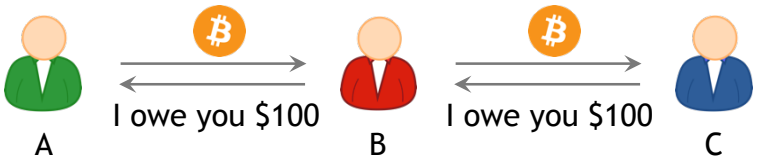
The problem:

- Alice would like USD for BTC
- Carol would like BTC for USD
- They don't trust each other

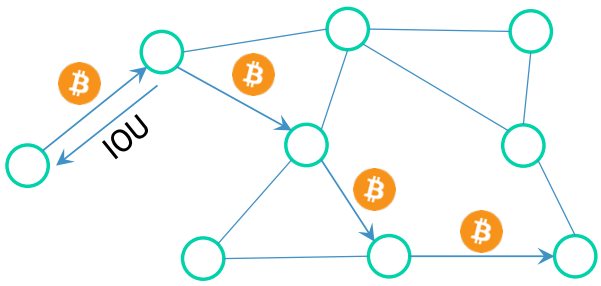
Luckily, they have a mutual friend Bob



Let's make this more efficient



... and scale it up



Pairs of friends pre-declare how much debt they're willing to extend.

Triangular debt cancellation means actual settlement may be rare.

Ripple

Decentralizes currency exchange
in the sense of disintermediation
using an Altcoin
via transitive trust

ripple

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What are we really talking about:

Technological alternatives to human institutions — legal, social and financial

Recall: Cypherpunk roots

Back to the Car Example

What are the problems with car ownership and trade?

- Security (theft)
- Disputes about sale terms

What happens in a smart property model?

Security is complex

Preventive, detective and corrective controls

Real-world solution relies on law enforcement

Bitcoin Security

Unsolved problem for the foreseeable future

Software security is partly a human problem

Excessive reliance can cause serious problems
- Loss of key → car turns into brick?

Dispute Mediation is complex

Fundamentally a human problem

Real-world solution:
court system, especially small-claims courts

Crowd Funding Security

Also fundamentally a human problem

Entrepreneur can take the money and run

Smart Property Model

Didn't solve existing (social) problems

In fact, made them harder to solve

Introduced new problems

Possible Benefits of Smart Property

- Efficiency for small transactions
- Anonymity & privacy
- Freedom to choose mediator

Crypto and the State

The state is one way to scale society past small groups where everyone trusts each other

Crypto is another

Dismantling the state is not an option

How can the two work together?

The big Opportunity

Find compelling use-cases for decentralization

Integrate into existing systems

Co-opt legal and regulatory practices