Bitcoin Scalability Solutions

SF Bitcoin Meetup
2015-05-26 Tuesday

Bitcoin Scalability

```
static const unsigned int MAX_BLOCK_SIZE = 1000000;
```

uhoh...

- Each node creates ~1 transaction (1*n)
- Each node stores all transactions (n*n)
- Total transactions stored = $O(n^2)$

Different Solutions

- The SQL Database Model
  - Very scalable, very fast
  - Off chain transactions implemented today with ChangeTip, Coinbase, others
- Altcoins
  - Many blockchains with inter-chain transfers
- Larger Blocks
- Payment Channels
  - Many payments between two pre-determined parties

SQL

- 100 users send their coins to 1 address
- The 1 node maintains balances in an SQL database -- User : Balance
- Users can transfer internally, deposit and withdraw
- Very fast, can support millions of transactions per second

SQL problems

- Likely to happen if no other actions taken
- Already very popular
- lim t→∞: Good delivery model

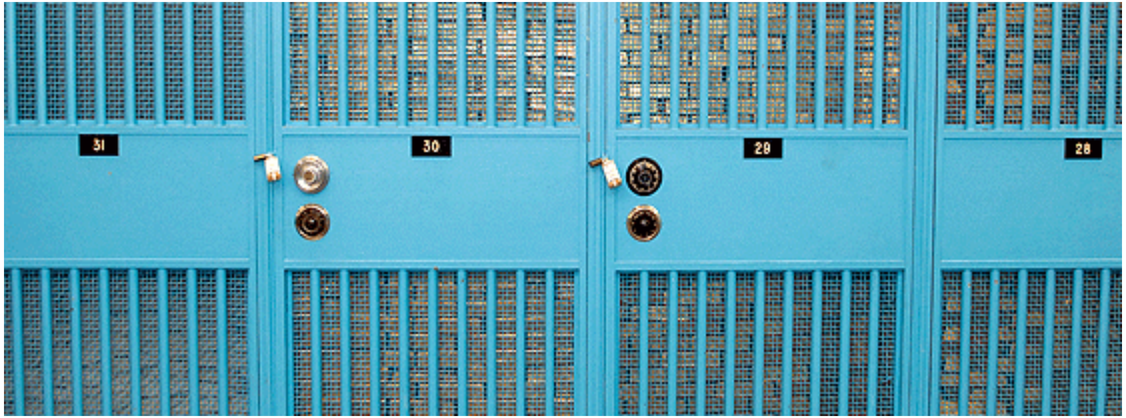


image: http://www.newyorkfed.org/aboutthefed/goldvault.html

Alts

- Sell your bitcoin, buy some NeatoCoin™
- Transact *fast* with NeatoCoin™ and it’s HydroFlex Negative BlockTimes™ (Block N+1 comes out before Block N. It’s non-causal!)
- When done transacting with NeatoCoin™, buy back your bitcoin.

Alt Problems

- The Altcoin Exchange is the same as the SQL server.

(Atomic cross chain txs could work, but not being used)

- Does NeatoCoin™ really work? Is it going to fall apart?
- If it doesn't work, you shouldn't use it
- If it works… why not just stick with NeatoCoin™? It's going to the moon.
- Not a good solution for Bitcoin, because it's not Bitcoin.

Larger Blocks

- Computers are great. Moore's Law works.
- Storage: 100MB block, always full, is 5TB /yr. 5 TB HD costs <1 BTC.
- If you were actually filling 100MB blocks every 10 min, a 5 TB HD would be way less than 1 BTC.
- CPU, RAM: Have you tried v0.10? So fast!!
- v0.11, pruning? Blockchain down to 1GB!!!

Larger Blocks - Big O

- n^2 is not that bad! it's polynomial! If it were 2^n, then it wouldn't scale
- While the total network cost is $O(n^2)$, for each users it's $O(n)$
- If the value of the network obeys Metcalf's law, then the value is $O(n^2)$, and value per user is $O(n)$
- Cost ≈ value, no problem!

Larger Blocks - problems?

- Miners are centralized anyways
- 20 MB still only gets you ~80 tx/sec
- Would need *much* larger blocks for billions of people
- What about the IoT? What if your fridge pays your drone to go pick up some eggs?
- Larger blocks can help. Necessary but not sufficient.

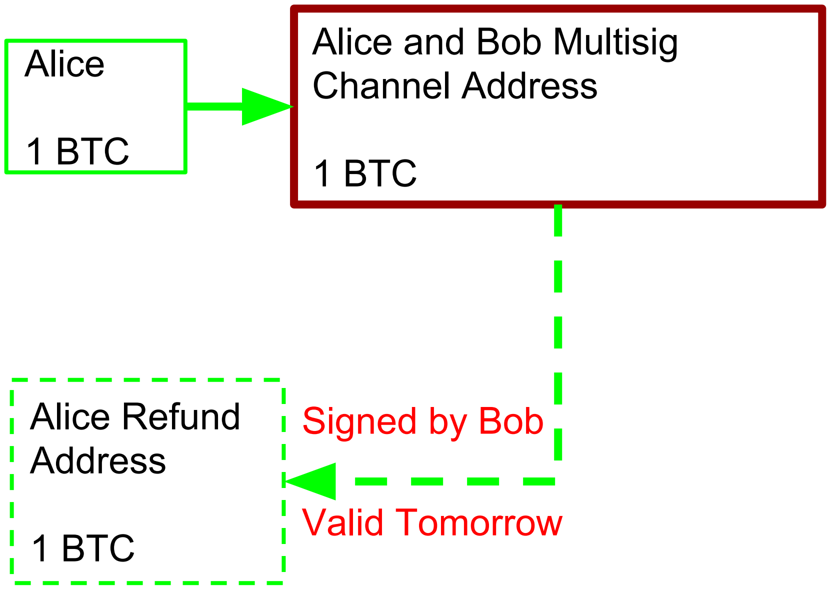
Payment channels

- Transactions can be delayed and aggregated before being cleared on the blockchain.
- Confirmed transactions are now only needed to open and close channels.

Payment Channels - Free lunch?

- Opt-in
- Many transactions
- Instant confirmation
- How to scale to many users

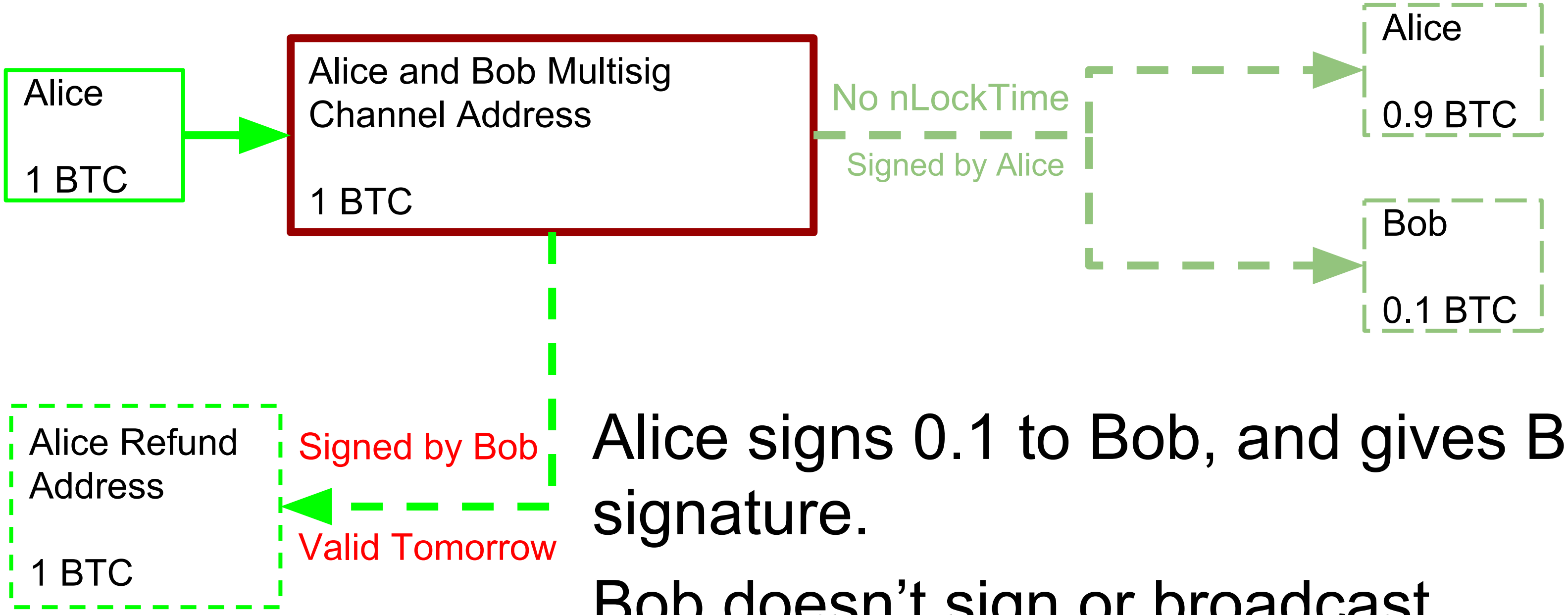
1:1 Payment Channels



First Alice gets a refund signed by Bob,
then sends to the multisig address.

Even if Bob disappears, she can get the coins back tomorrow.

1:1 Payment Channels

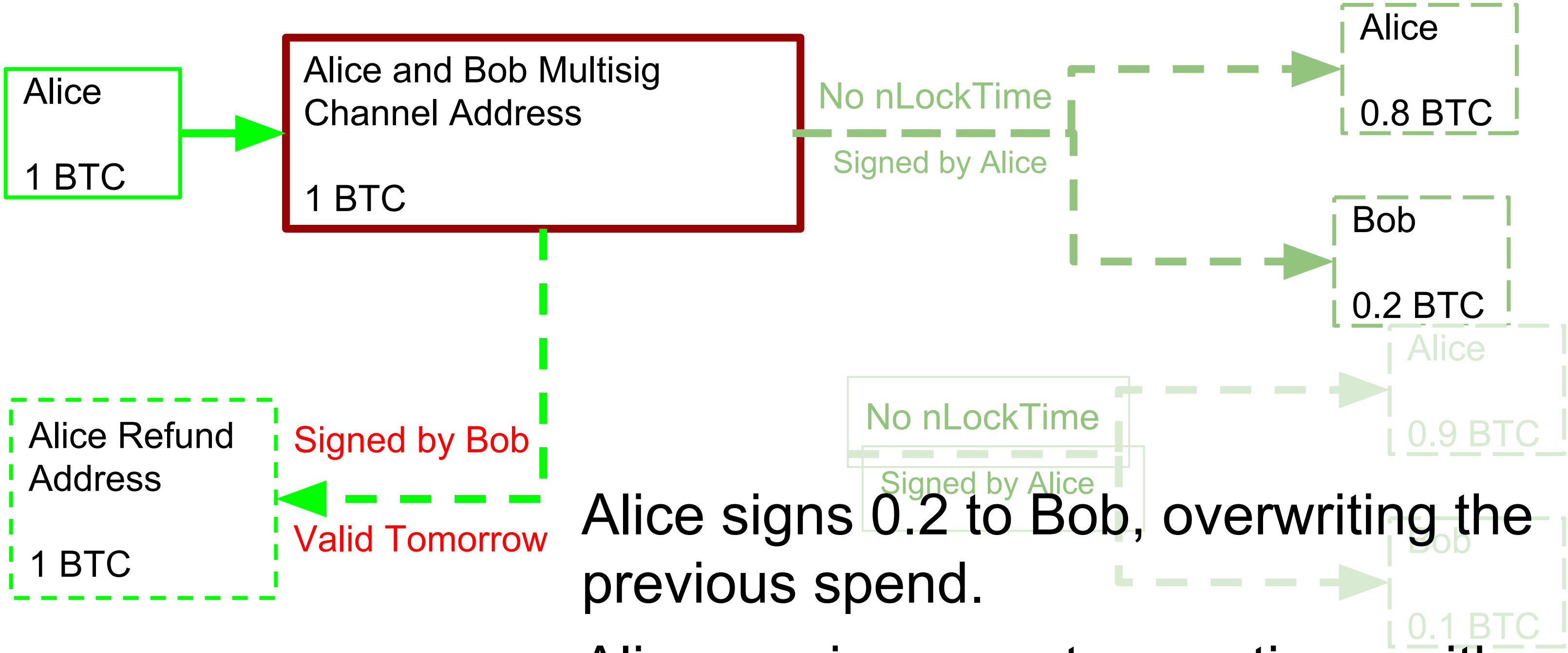


Alice signs 0.1 to Bob, and gives Bob the signature.

Bob doesn't sign or broadcast.

The signature itself is the payment.

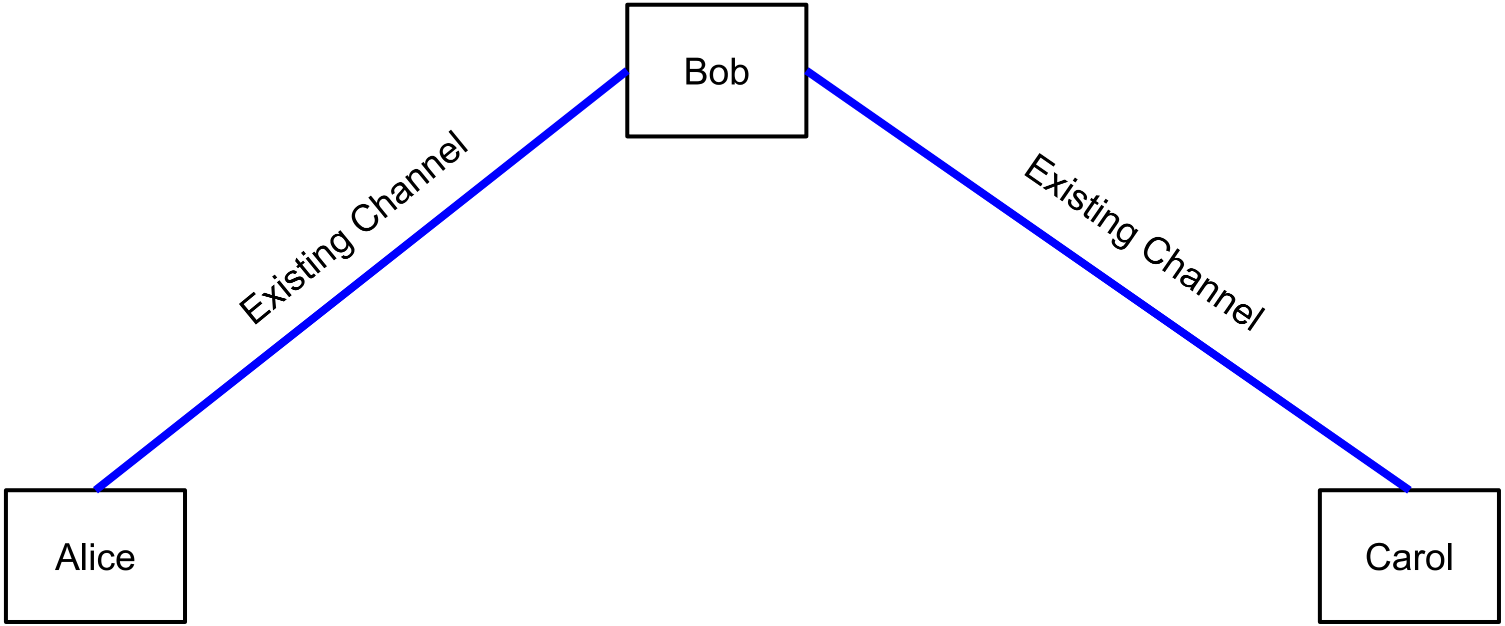
1:1 Payment Channels



Alice signs 0.2 to Bob, overwriting the previous spend.

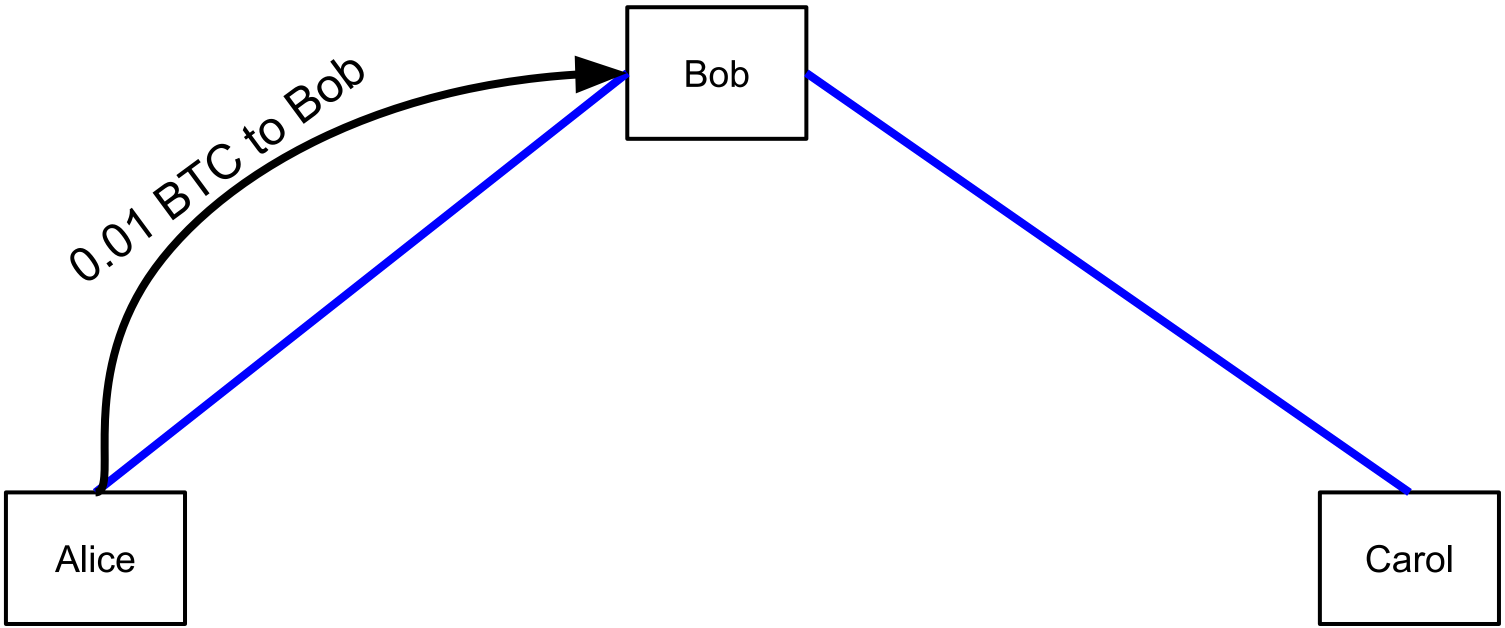
Alice can increment many times without transaction fees.

3 party - optimistic (iterative)



Alice wants to pay Carol. They both have a channel open with Bob

3 party - optimistic (iterative)



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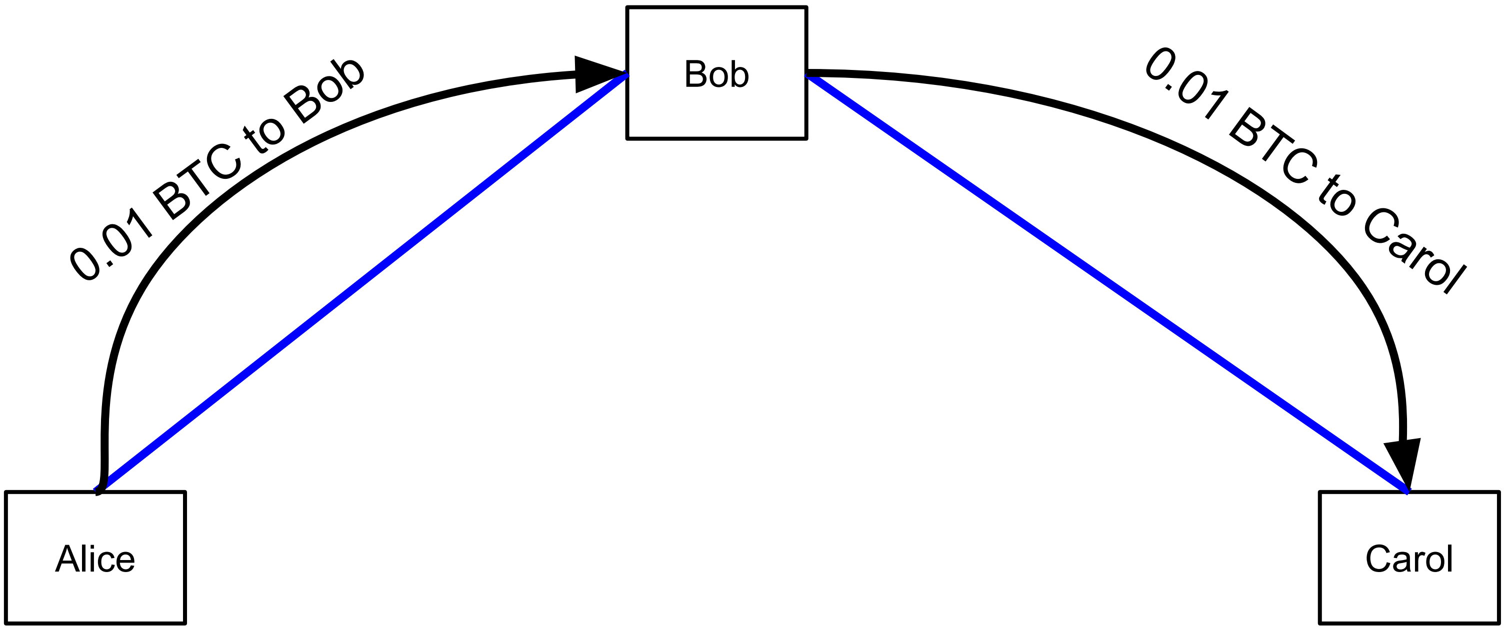

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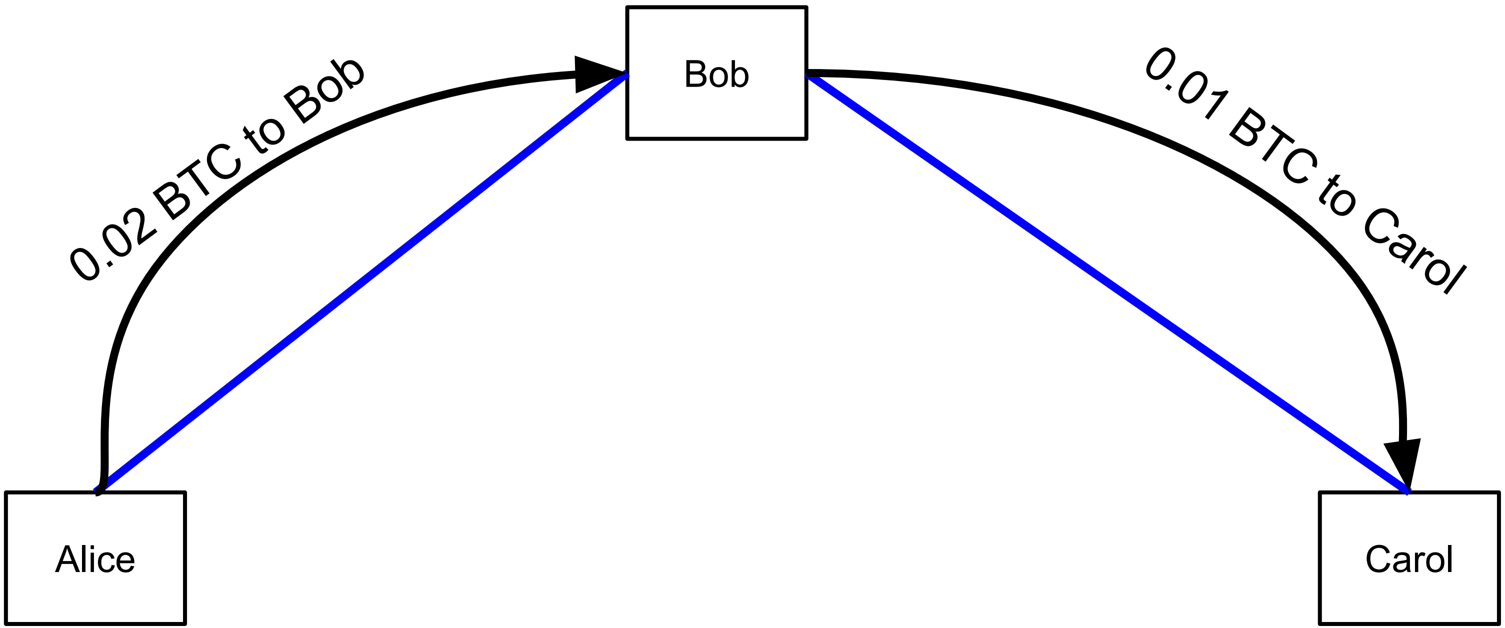

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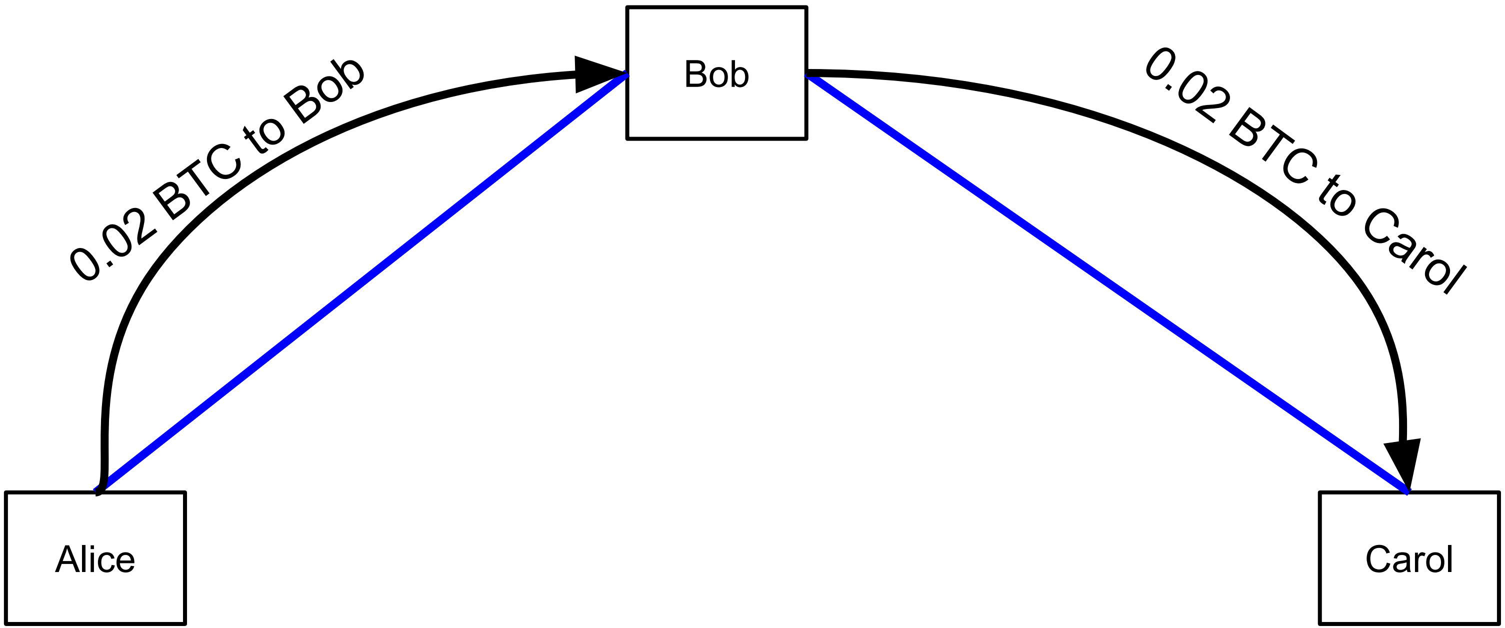

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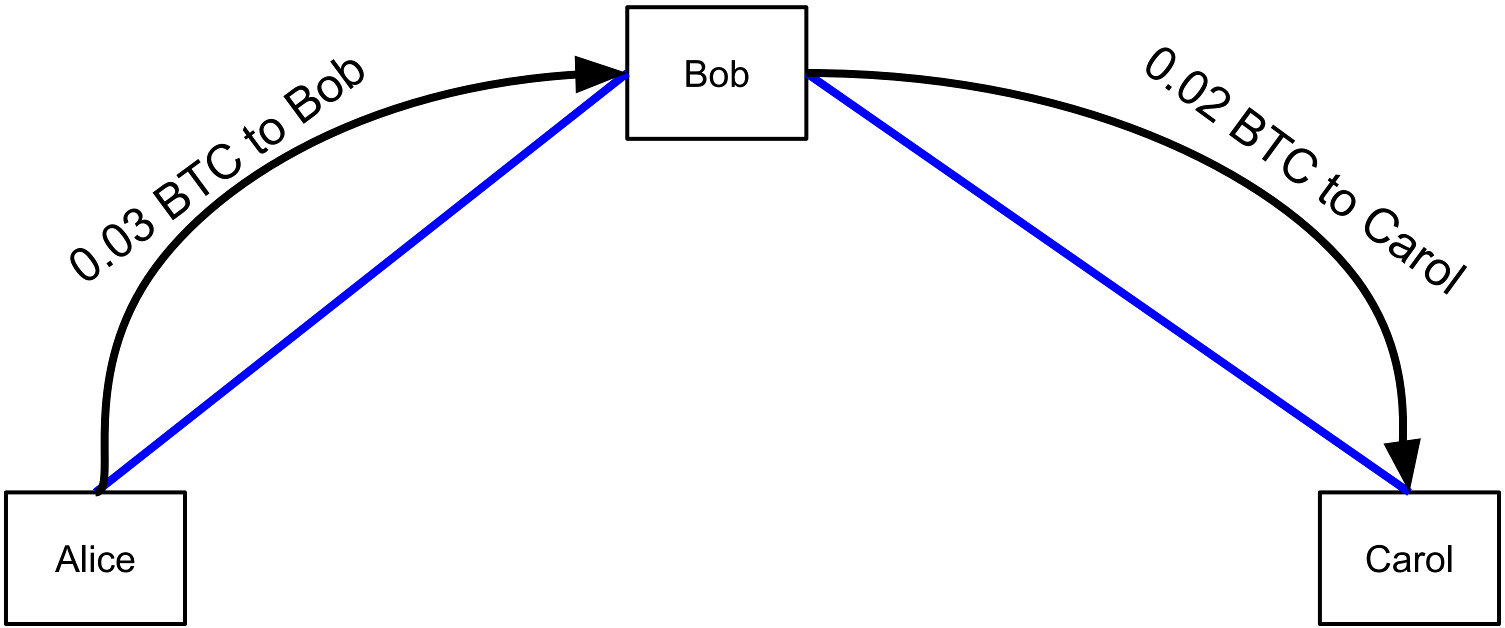

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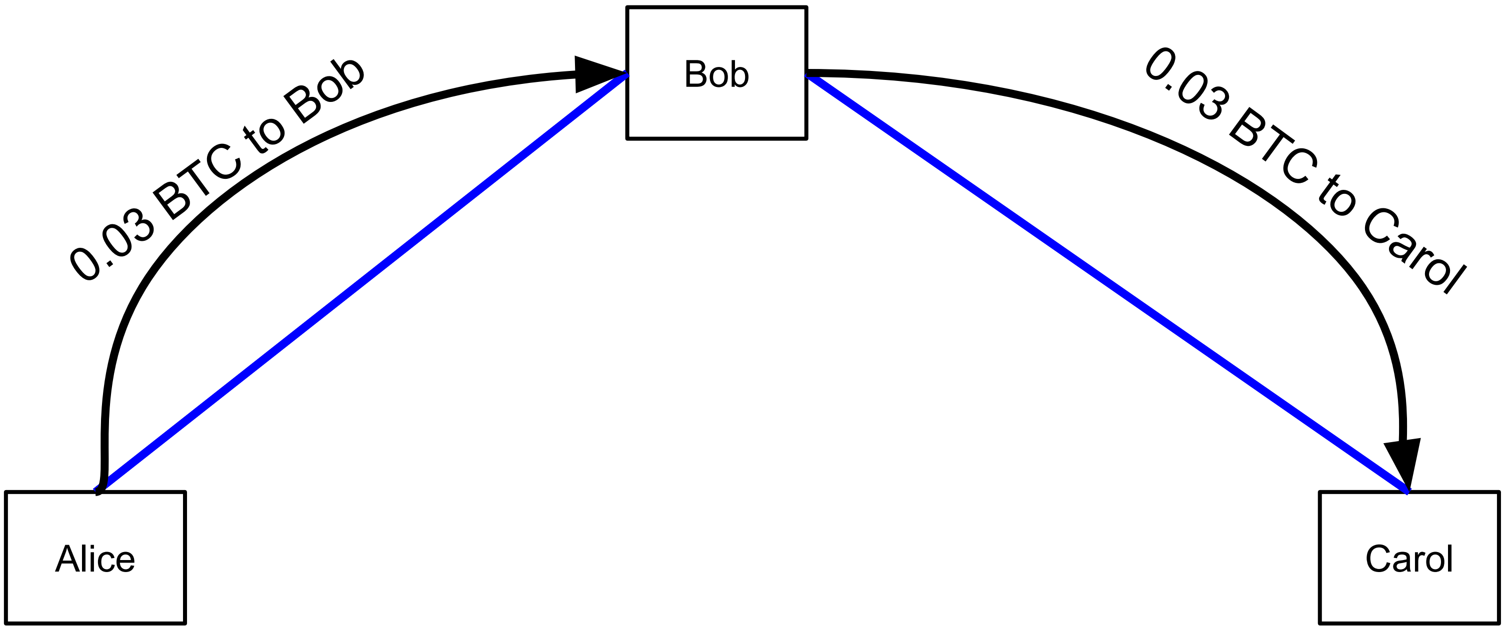
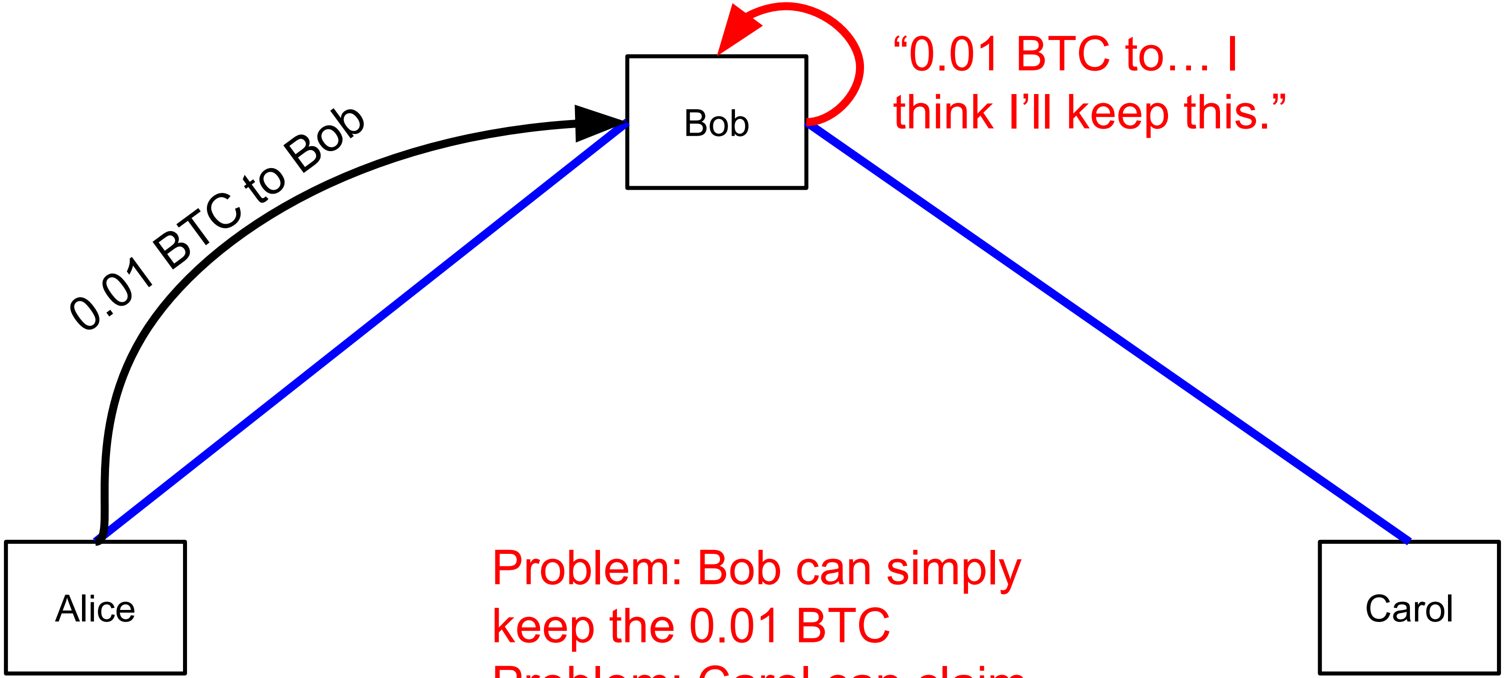


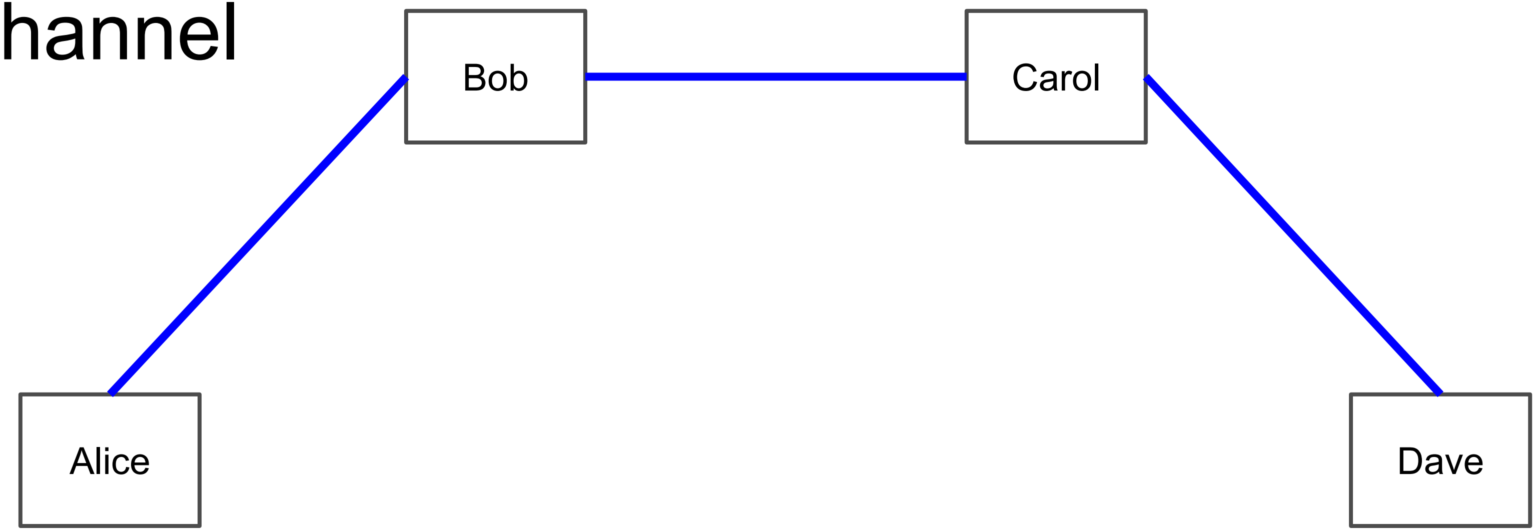
3 party - Trust Issues



Problem: Bob can simply keep the 0.01 BTC
Problem: Carol can claim she never got the coins!

3+ party - trustless

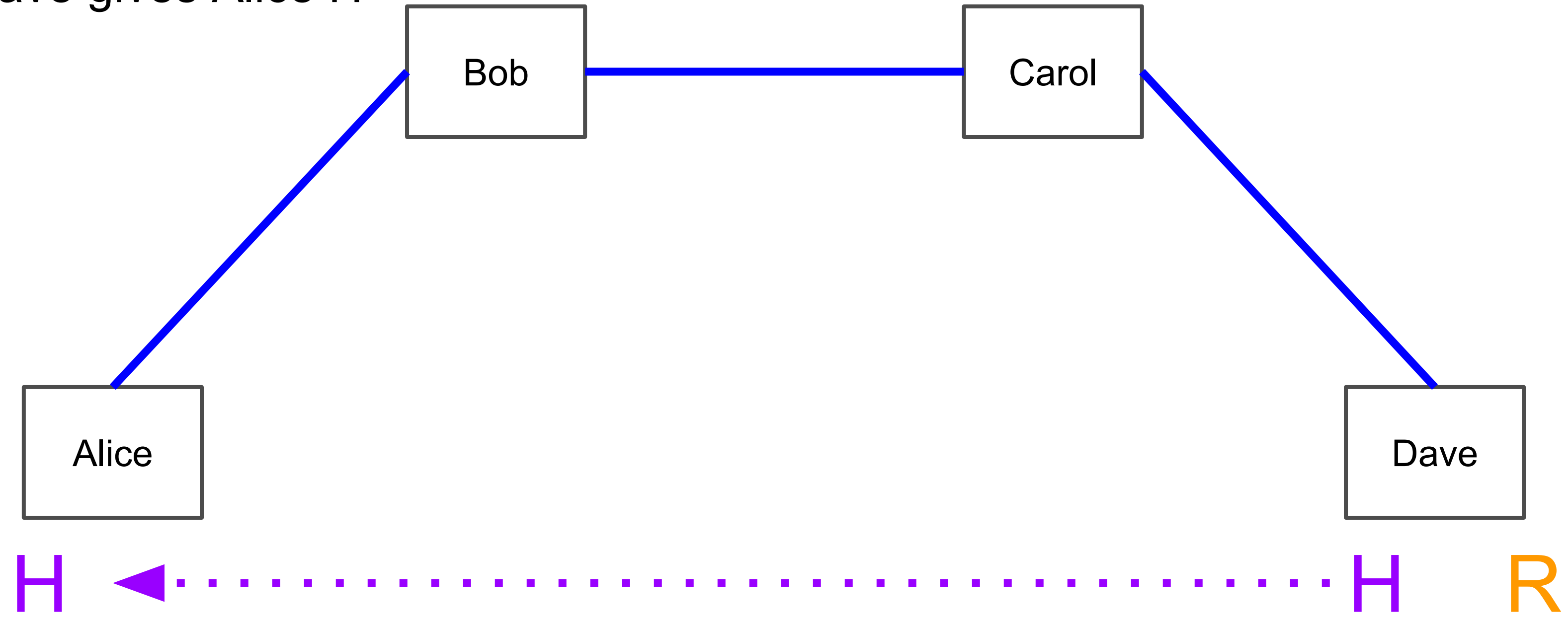
Alice wants to pay Dave without opening a new channel



3+ party - trustless

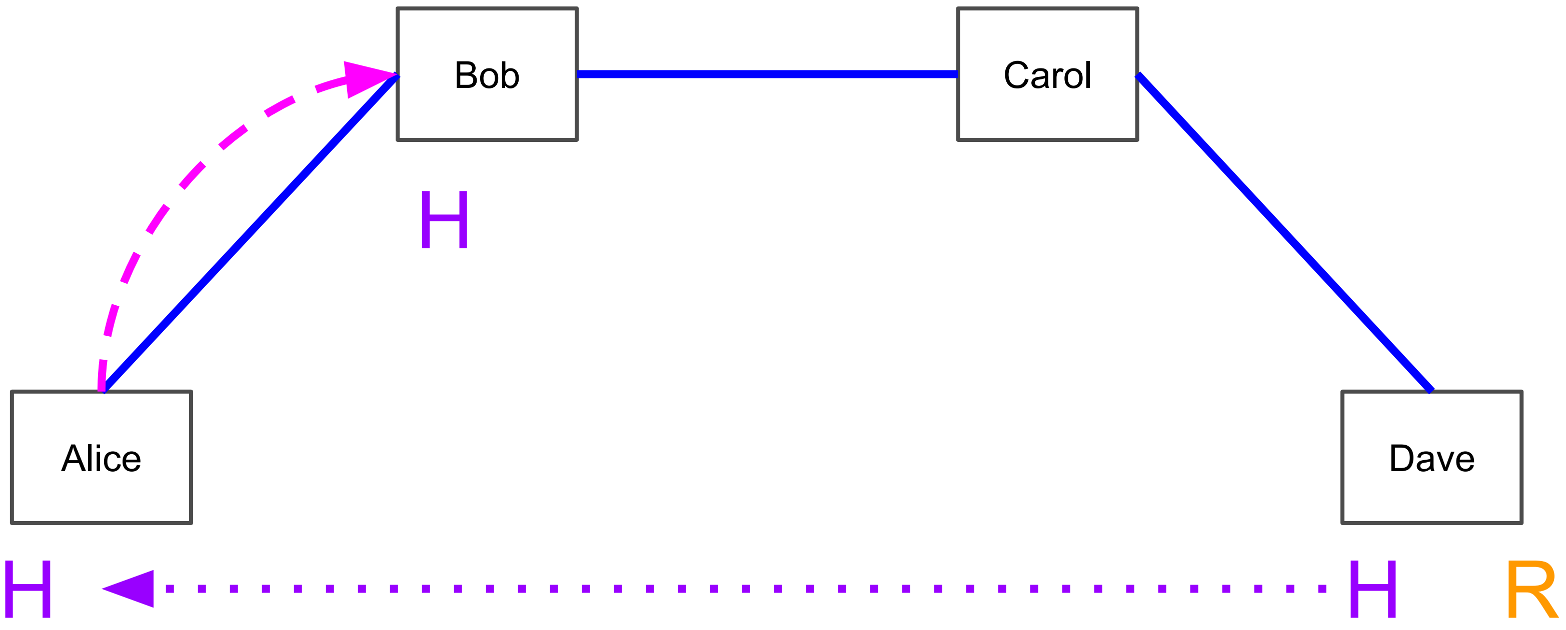
Dave makes a random number R and hashes it to H.

Dave gives Alice H



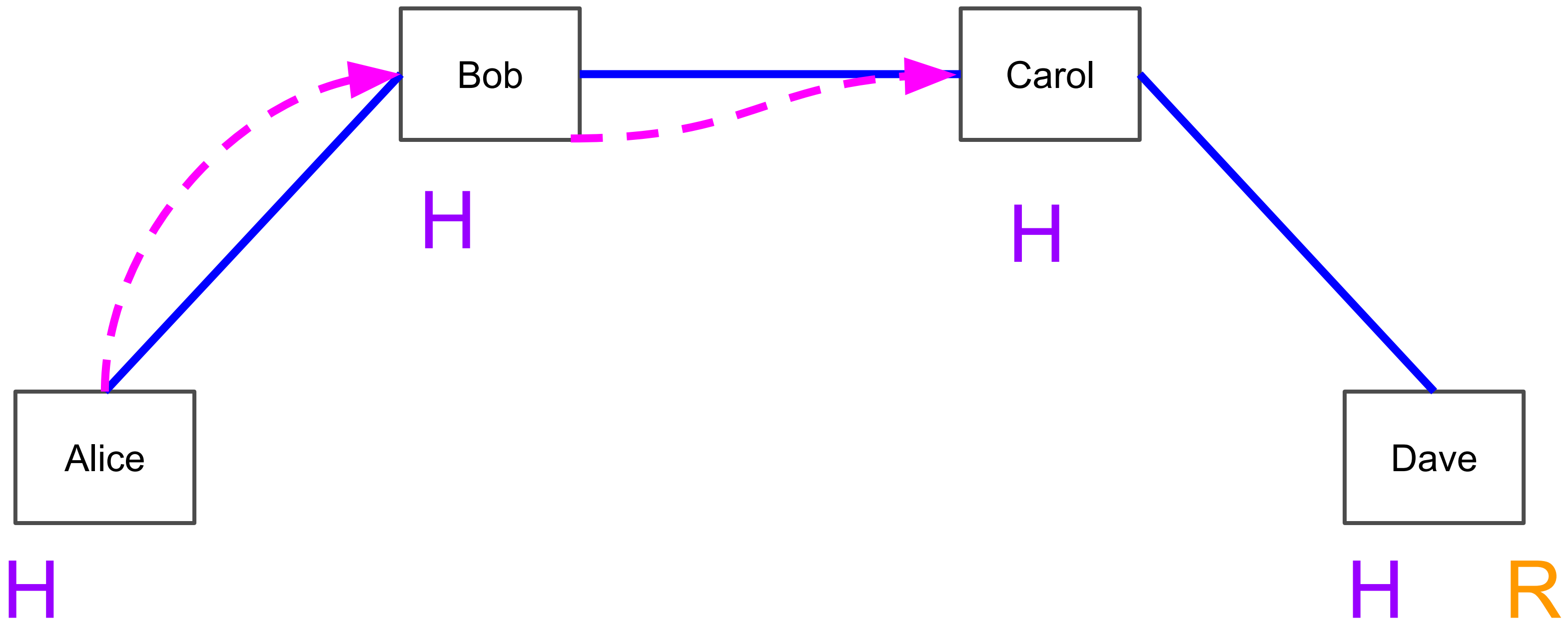
3+ party - trustless

Alice pays Bob, but only if he knows R, the pre-image of H



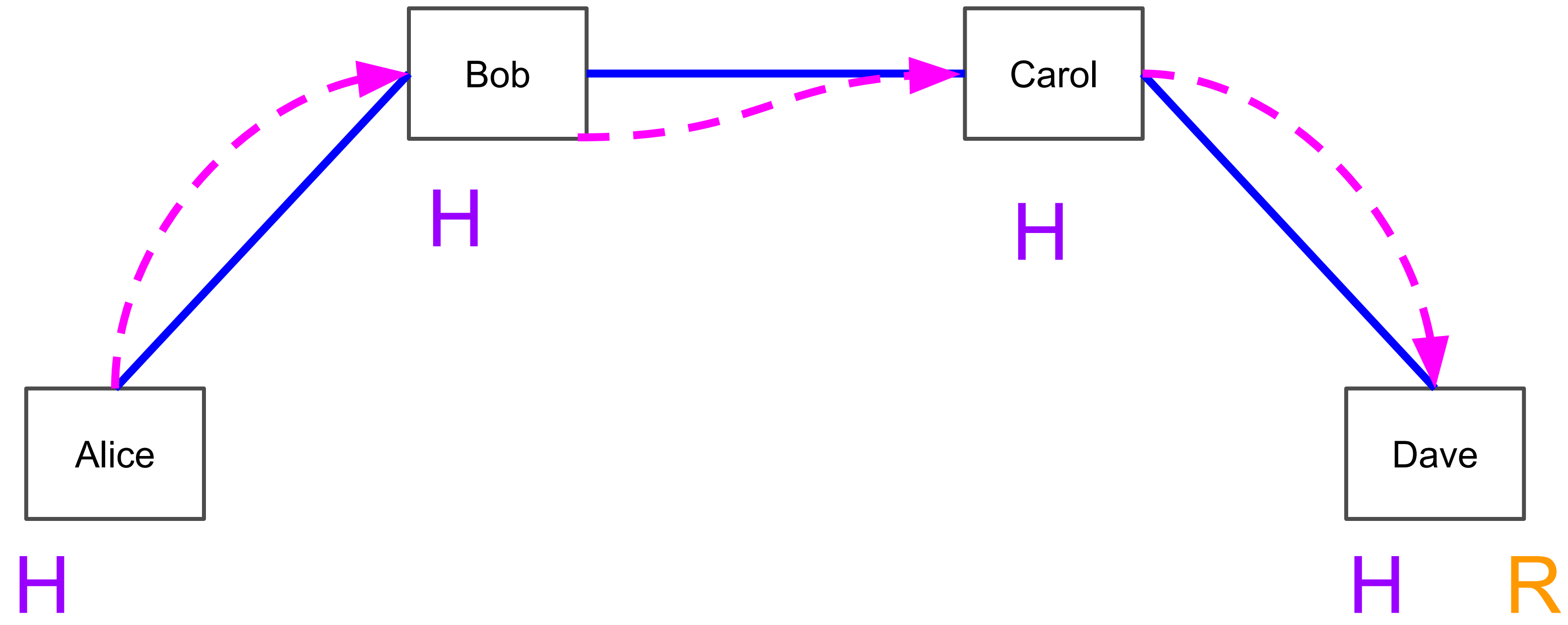
3+ party - trustless

Bob pays Carol, but only if she knows R, the pre-image of H



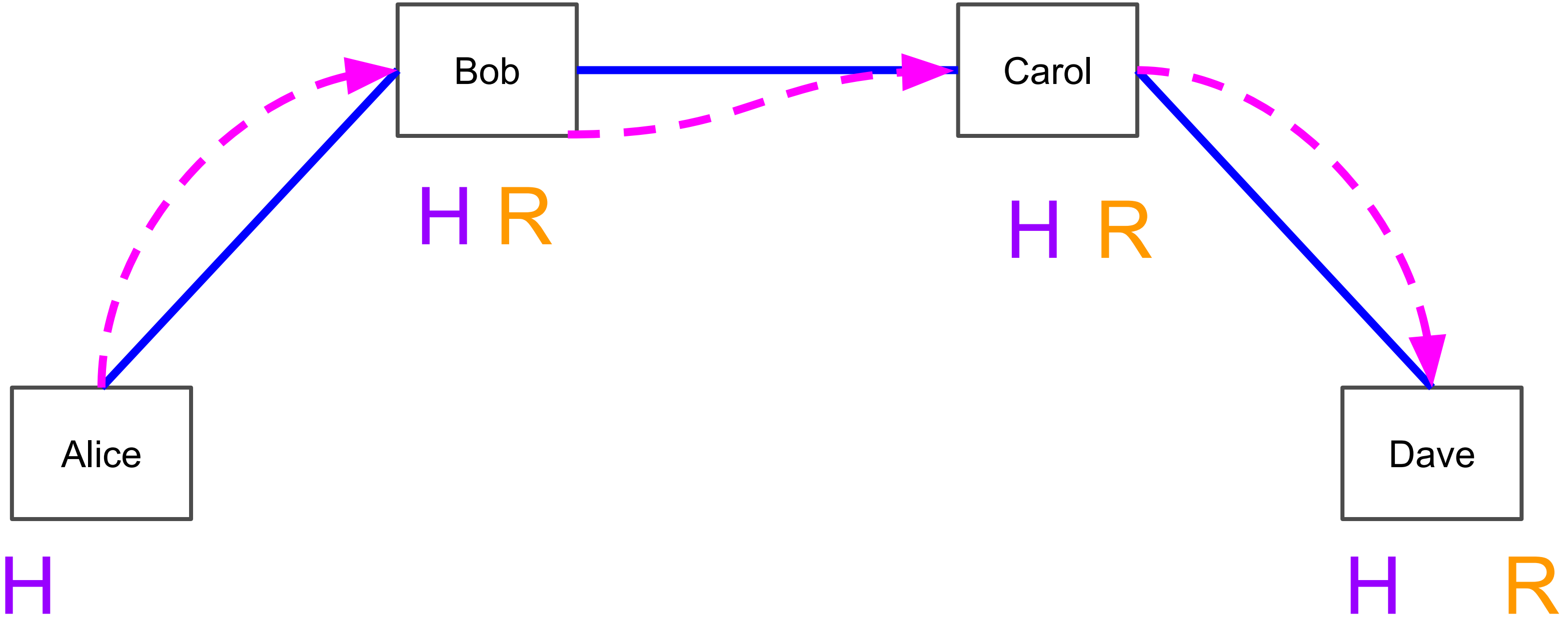
3+ party - trustless

Carol pays Dave, but only if he knows R… and he does!



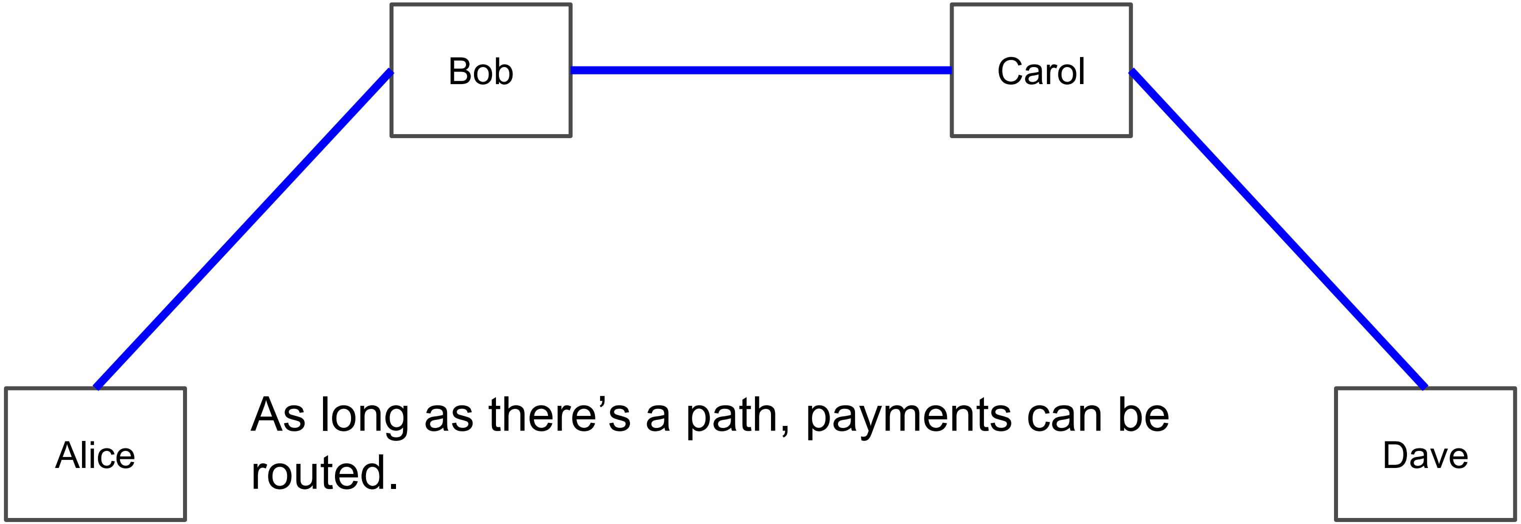
3+ party - trustless

When Dave receives the payment, he must reveal R. Revealing R allows Carol and Bob to receive their payments.



3+ party - trustless

Lots of payments to anyone within the networks, without the need to make new channels.



As long as there’s a path, payments can be routed.

… kind of like the Internet!

Using Time for Atomicity

- Historical norm for using time as the primary method for atomicity in financial markets with multiple parties
    - T+3 in equities
    - Correspondent Banking
    - “Overnight” anything

Systemic Coin Theft

- Isolated attacks don’t work
  - They’ll lose all their money, too!
- Systemic attacks unlikely but disastrous
  - Millions of channels with lots of coins in channels
  - Simultaneously broadcast previous channel states where the attacker gets more coins
  - Pay very high miners fees
    - Child pays for parent

Mitigating Systemic Risks

- Blocks should be mostly full, a fee market is good!
- Possible solution(s):
  - Soft-cap block size
  - Some sidechain thing (put soft-cap in this)
- Blocks full most of the time, credible threat that the block size can be increased quickly.

Economic Implications

- Coins locked up in channels
  - Reserved in case counterparty receives funds
  - Immediately available to spend, but some time-value of money allocated in relationship
  - Intermediary nodes have funds locked up
- Reduction in money supply may increase the price per bitcoin to accommodate necessary amount of economic transactions

Fee Market

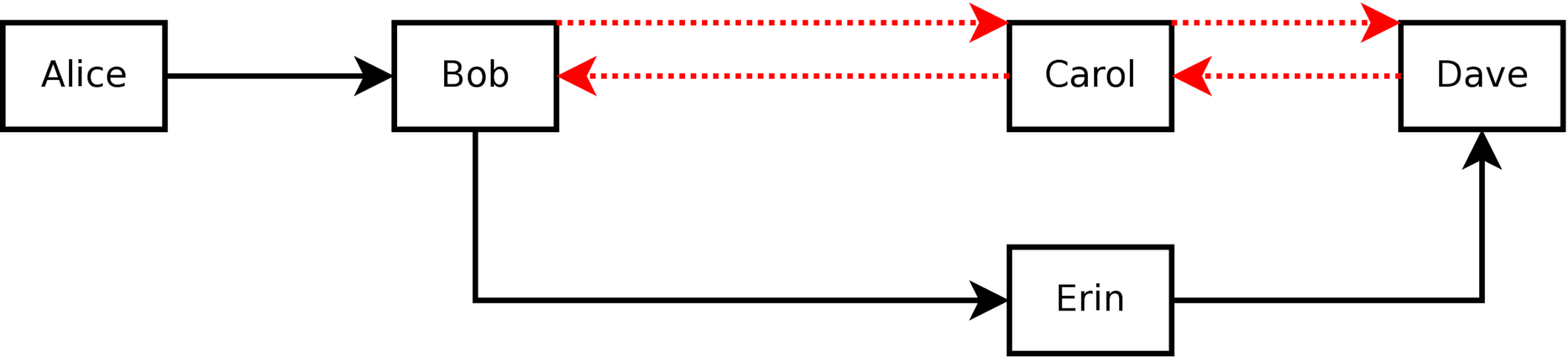
- Fee market will exist with Lightning paid to liquidity providers
  - Separate from on-blockchain fees
- Fees can be positive or negative
  - Maybe a lot of coins are moving across a channel, if you have a relationship between both, you can keep that channel open and receive some fee

(Speculative) Economic Implications

- Economic incentives are aligned with keeping channel paths open and available
    - “Network Liquidity”
- Ratio of funds locked up to funds available to one’s channel counterparty
    - “Channel Liquidity”

Providing Liquidity

Erin, an end user with a smartphone, helps with liquidity (and earns coins) on frequently used channels.



(Speculative) Economic Implications

- Channel liquidity is what is really being locked up
- Fees will also exist if you want high amount of funds available in the channel
  - Fees will be very very cheap
  - Long-term demand liquidity reflects in higher exchange rates to accomodate

Applications

- Micropayments
  - Pay for publishing. Newspapers get paid per view, donation for per song played on your MP3 player, etc.
- Pay for Bandwidth (Cell phones)
- Instant Payments: Paying for coffee actually works
  - Arbitrage

What Lightning Network Needs

- Malleability fix which allows spends from unconfirmed transactions
- Relative Maturity
  - (a.k.a. OP_RELATIVECHECKLOCKTIMEVERIFY)
- Accounting for bursts in block sizes
- Coding the wallet
  - Network communication layer
  - Will take some time

Bitcoin Scalability Solutions

Questions?

Thanks for listening!