Fast and secure global payments with Stellar

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Monday, October 28, 2019

Things we take for granted

A bank account in a stable currency such as USD

Access to well-regulated investments

Cheap international money transfers

Globally accepted, fee-free credit cards

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Vanguard®

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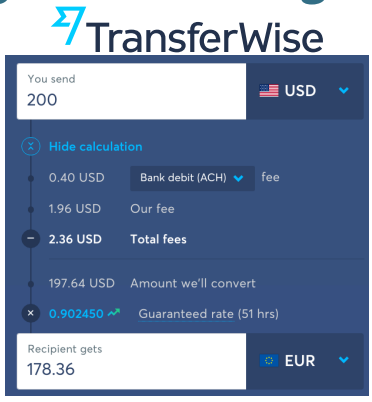

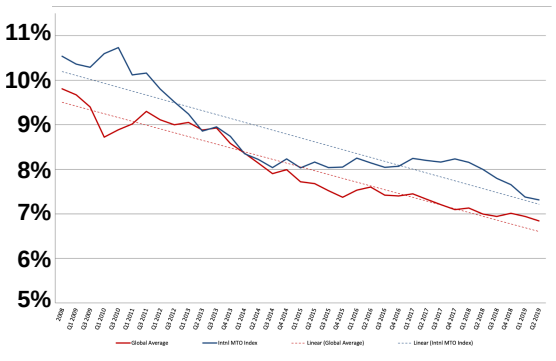

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All No Foreign Transaction Fee Cards

m-pesa

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Stellar: equitable access to assets

1. **Open membership**
   - Anyone can issue, trade, and hold assets
   - All developers access the same API, from Ph.D. students to Franklin Templeton or IBM
2. **Issuer-enforced finality**
   - Security of issued tokens depends only on issuer (what we expect today)
   - Still need secure servers, but issuer owns or designates them
3. **Cross-issuer atomicity**
   - Trade any asset for any other (ensures you can bootstrap markets)
   - Get the best price on any trade without trusting your trading partner
   - Atomically trade through multiple assets w/o exchange-rate risk
     (E.g., trade NGN $\rightarrow$ Sketchy-Asset $\rightarrow$ PHP with no risk from Sketchy-Asset)

Non-solutions

Nacha

中国人民银行
THE PEOPLE'S BANK OF CHINA

Extend national payment network (ACH, SEPA, UPI) globally

- Requires compliance with national regulations, closed to new assets

Everyone just issues and manages their own assets

- Can't pay or trade across systems, closed to new assets

Move Paypal onto Ethereum as an ERC-20 token

- Double redemption risk not under issuer's control

Non-solutions

微信支付
WeChat Pay

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Non-solutions

Name	Symbol	Market Cap	Algorithm	Hash Rate	1h Attack Cost	NiceHash-able
Bitcoin	BTC	$188.00 B	SHA-256	78,549 PH/s	*$765,484*	0%
Ethereum	ETH	$19.26 B	Ethash	169 TH/s	*$95,684*	2%
BitcoinCashABC	BCH	$5.47 B	SHA-256	2,301 PH/s	*$22,422*	1%
Litecoin	LTC	$4.38 B	Scrypt	303 TH/s	*$20,501*	2%
BitcoinSV	BSV	$2.41 B	SHA-256	958 PH/s	*$9,337*	3%
Monero	XMR	$1.34 B	CryptoNightR	304 MH/s	*$4,619*	2%
EthereumClassic	ETC	$766.86 M	Ethash	12 TH/s	*$6,823*	31%

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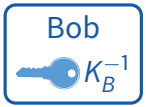

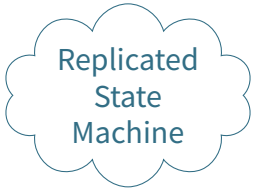

Global replicated state machine (RSM) executes transactions to keep ledger state

- Accounts named by public key authorizing operations on the account
- Accounts can issue assets; issuing account part of asset name

Transactions guarantee atomicity

- Multiple operations from multiple accounts with either all succeed or all fail
- *Path payments* atomically trade through multiple assets (e.g., $1\,K_D\$ \rightarrow 1\,K_C\$ \rightarrow 1\,K_B$ babysit)

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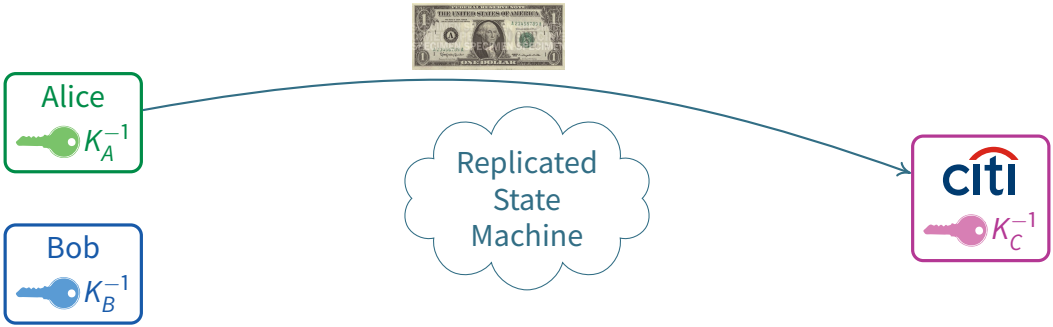

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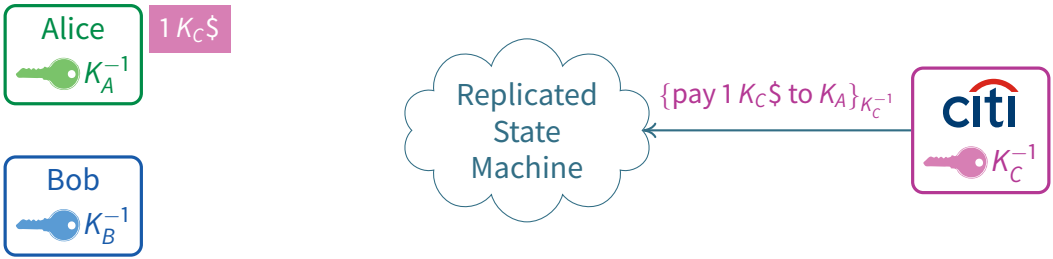

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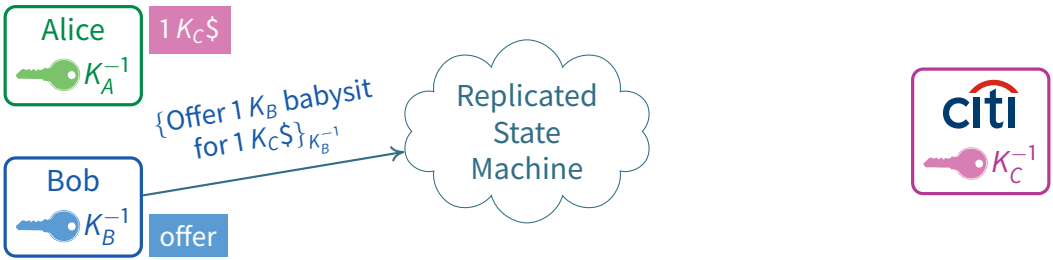

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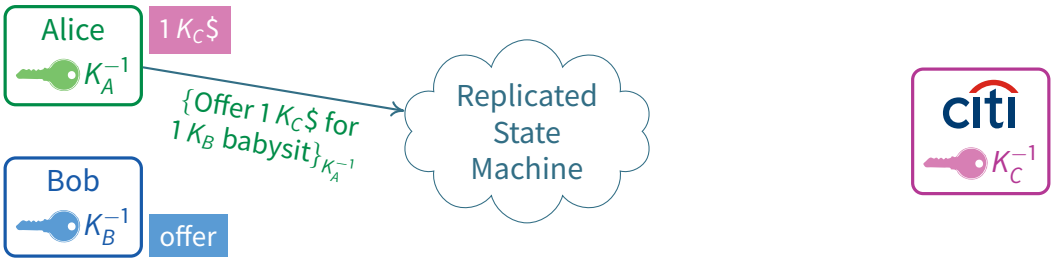

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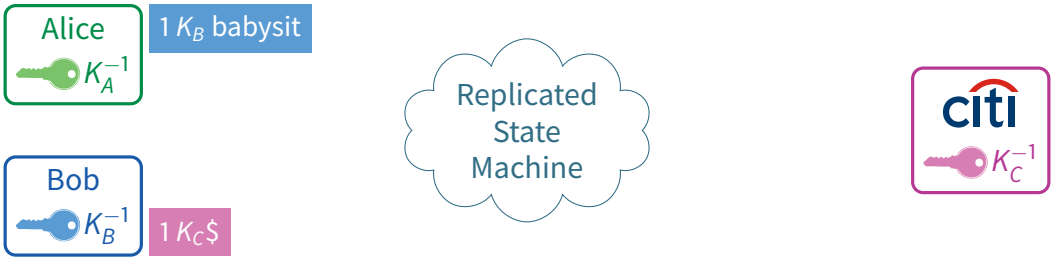

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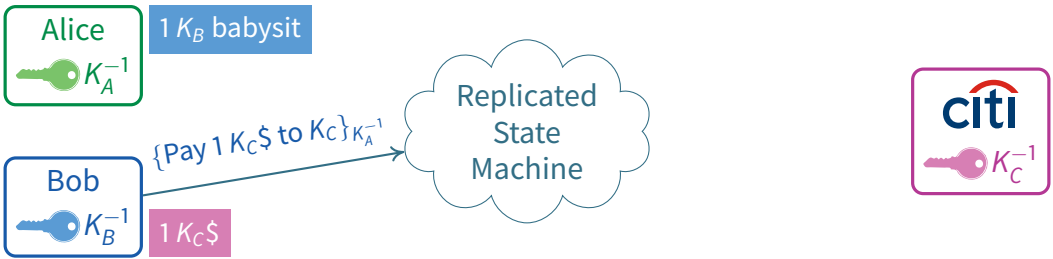

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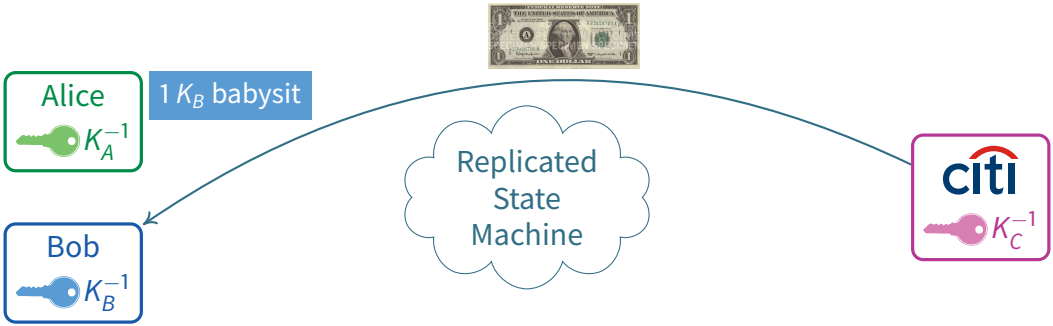

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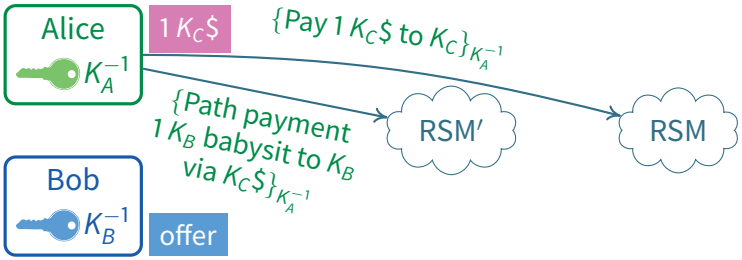

Model only works if everyone agrees on ledger state

- If ledger forks, system vulnerable to *double-spend attack*
- E.g., Alice gets both babysitting and $1, Bob can't redeem $K_C$$

Solution: Bob had better *follow* the server Citi uses to redeem $K_C$$

- Unless/until that server agrees, Bob shouldn't recognize Alice's babysitting credit

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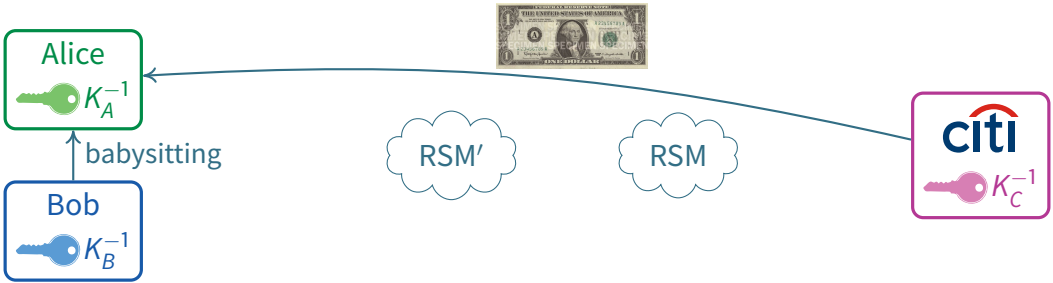

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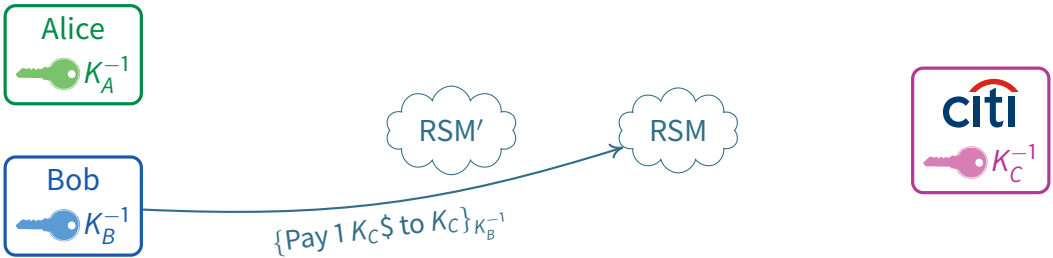

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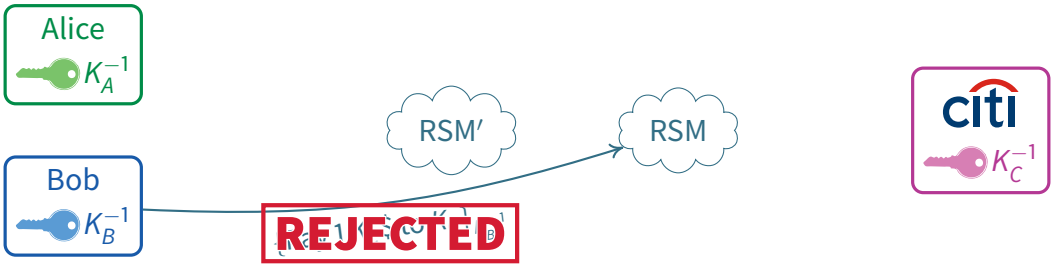

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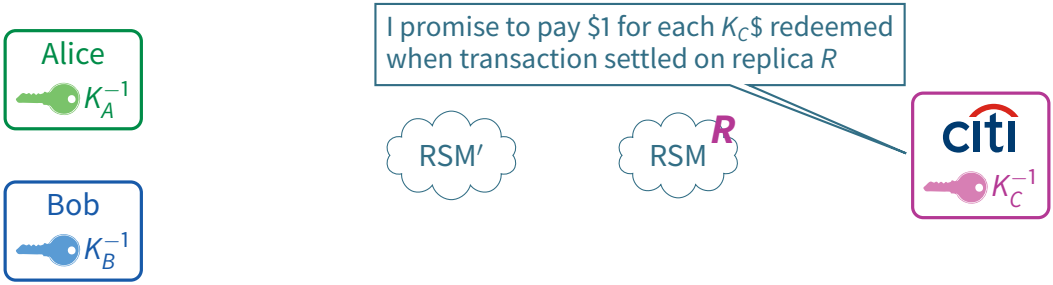

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The Internet hypothesis

Will two organizations that don't follow each other agree on ledger state?

- Yes if the follow graph transitively converges

Hypothesis: any two nodes transitively follow a common node

- Empirically true of Internet (e.g., China⟷Stanford⟷Google) and legacy payments
- And if they don't, maybe a fork is okay (risk limited to in-flight transactions)

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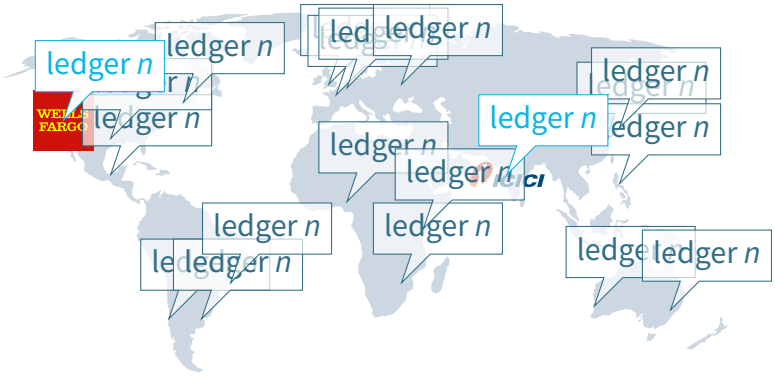

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Byzantine agreement from the Internet hypothesis

Stellar consensus protocol (SCP) secures Stellar ledger

- Safety and liveness formally verified for arbitrary configurations

Key idea: broadcast protocol steps conditioned on other nodes' steps

- Take step if all nodes mutually satisfied

For availability, must generalize "follows" to sets of peers, called *quorum slices*

- Take step if any quorum slice unanimously willing
- E.g., slices(v_1) = alls set comprising a majority from each of 3 organizations

Definition (Quorum)

A *quorum* is a set of nodes containing at least one slice of each non-faulty member.

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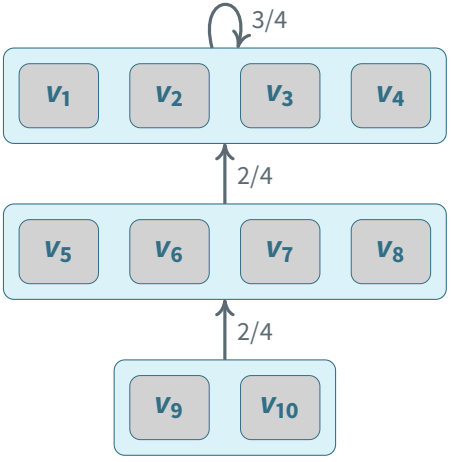
Quorum slices in action



Top tier: slice is three out of $\{v_1, v_2, v_3, v_4\}$ (including self)

Middle tier: slice is self + any two top tier nodes

Leaf tier: slice is self + any two middle tier nodes

Like the Internet, no central authority appoints top tier

- But market can decide on *de facto* tier one organizations
- Don't even require exact agreement on who is a top tier node

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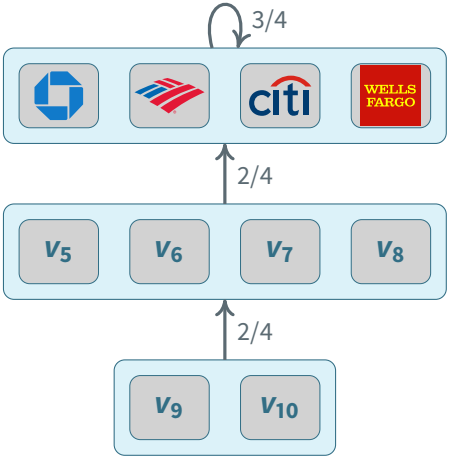

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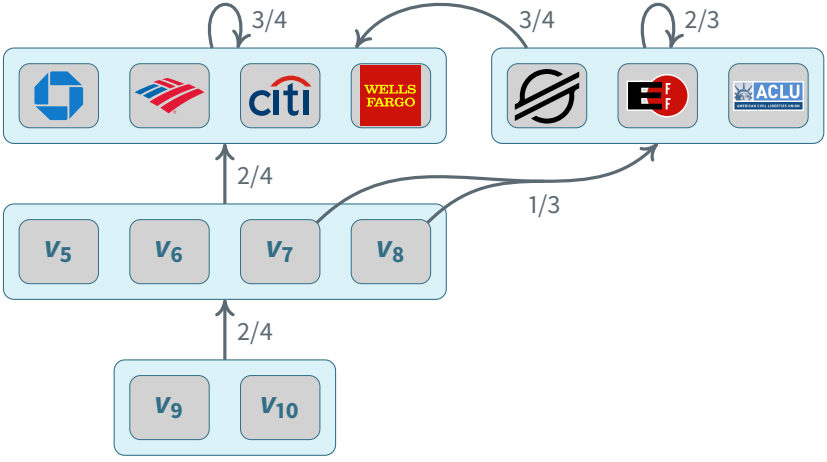

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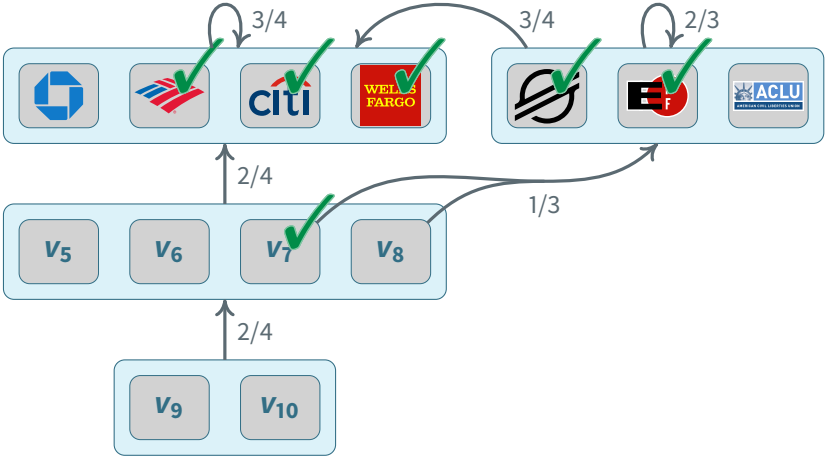

Example: Citibank pays $1,000,000,000 to v_7

- Colludes to reverse transaction and double-spend same money to v_8
- Stellar & EFF won't revert, so ACLU cannot accept and v_8 won't either

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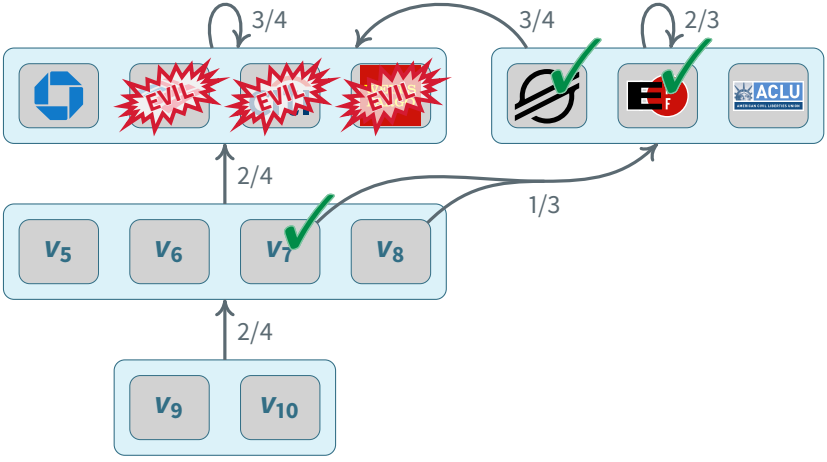

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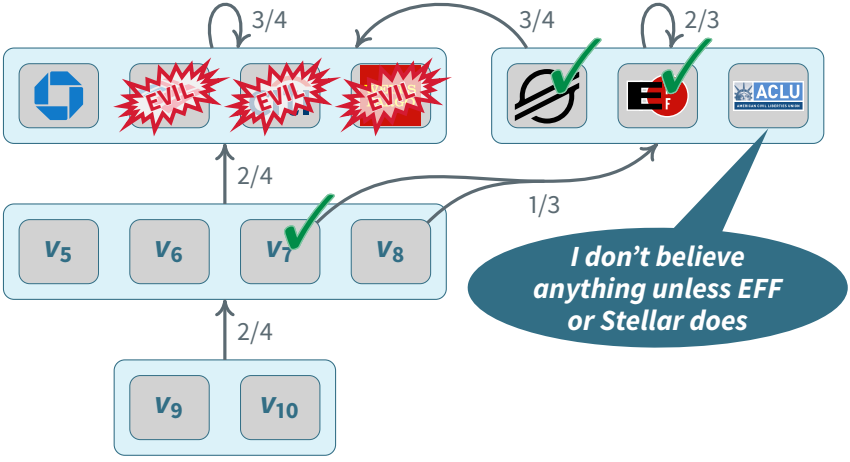

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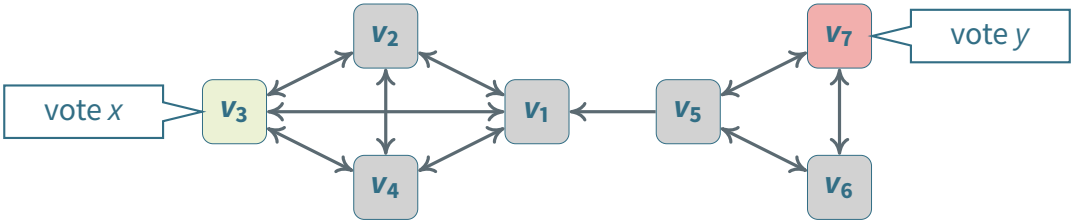
Fundamental building block: federated voting



Vote for a statement if you believe it has a chance of prevailing

- E.g., $x =$ "Choose transaction set T for ledger n in ballot b"

Accept if you are in a quorum that unanimously votes for or accepts x

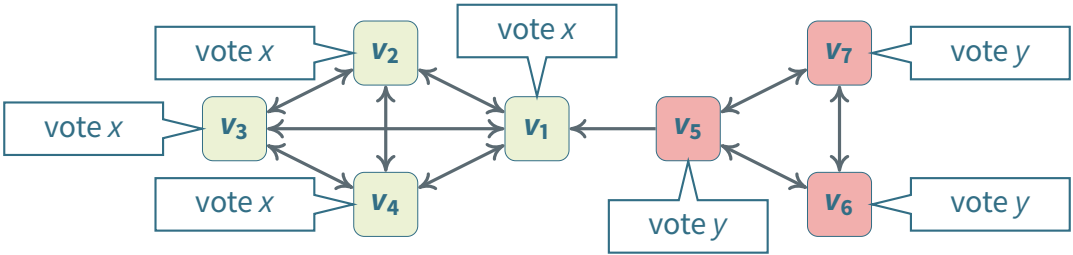
Also accept if each of your slices has accepting member

- Either it's true or you have lost liveness

Confirm (externalize) statement if you are in a quorum that unanimously accepts

Key property: if one "intact" node confirms a statement, all eventually will

Fundamental building block: federated voting



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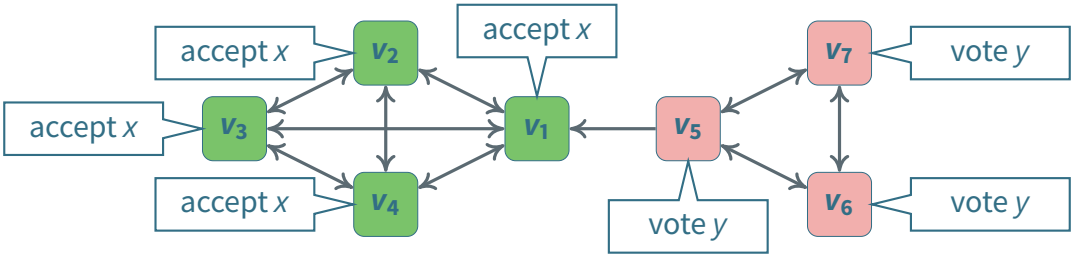

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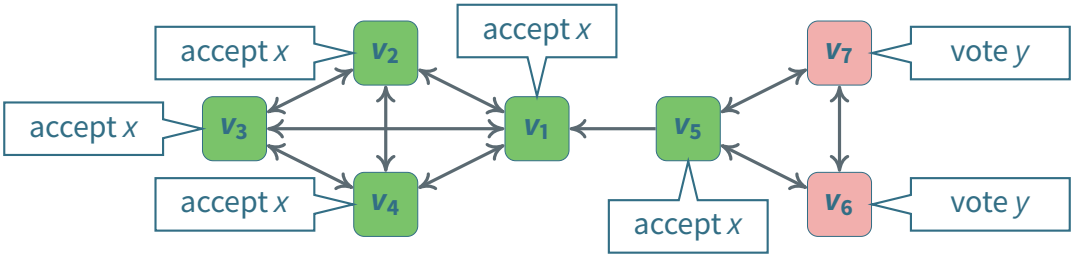

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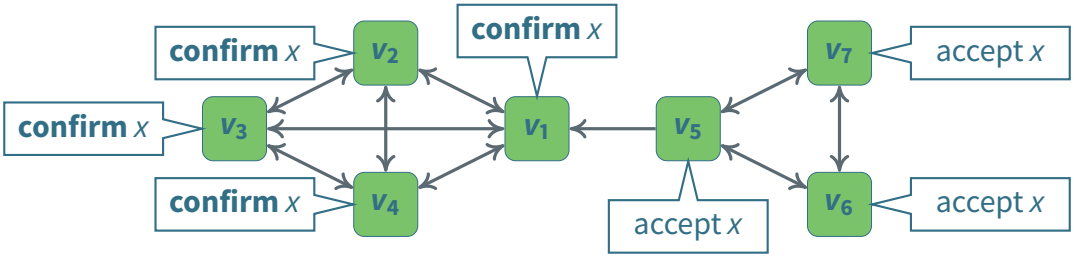

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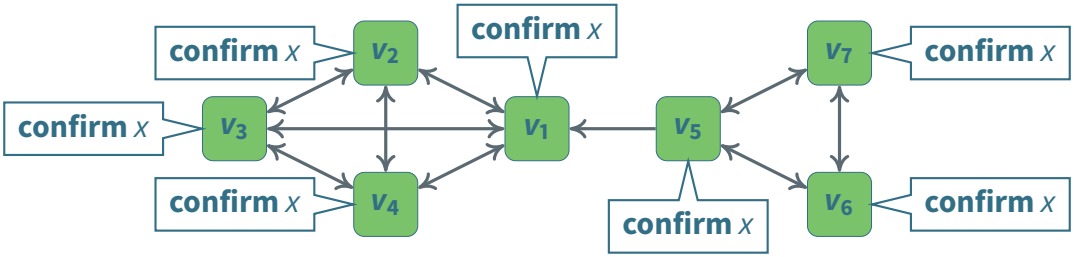

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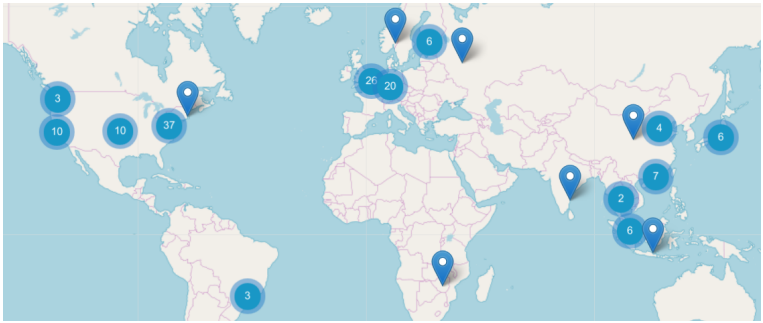

Production network has been running 4 years

- Ledger closes every 5 seconds, currently allows 1,000 operations/ledger
- Presently 133 nodes, 74 validators, 17 “tier-one” nodes run by 5 organizations

Shows open-membership Byzantine agreement is viable

30+ assets tracked on 3rd-party stellar.expert, about to be many more

First Stellar conference, Meridian, next week in Mexico city

Questions?

www.stellar.org