Presentation Title

Optional Subtitle

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Outline

Outline

TrustChain

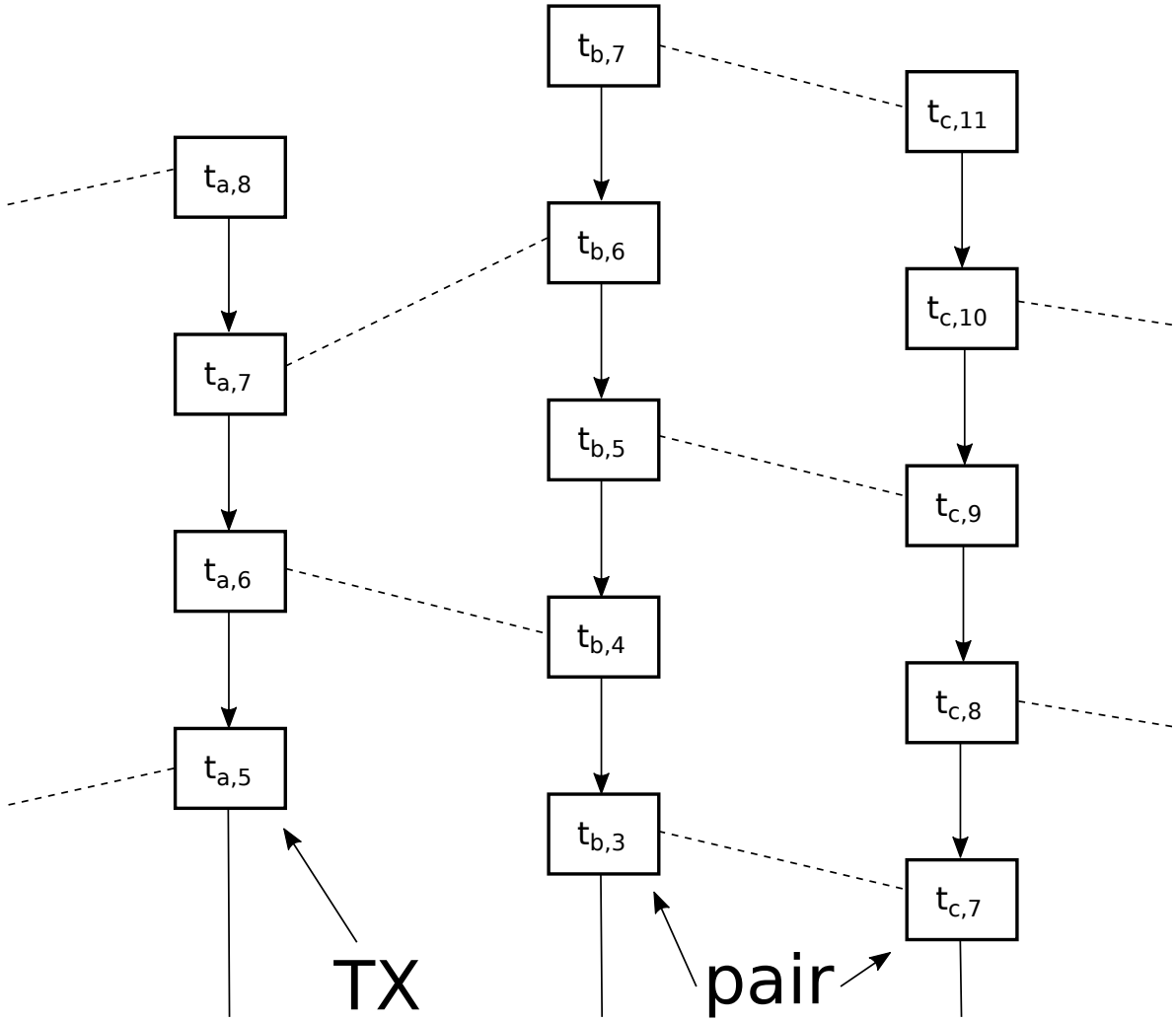


Figure: Every node has a chain. *TX block* is a six-tuple: $t_{i,j} = (\mathrm{h}(b_{i,j-1}), h_s, h_r, s_s, s_r, m)$, one transaction results in two TX blocks—*a pair*.

TrustChain

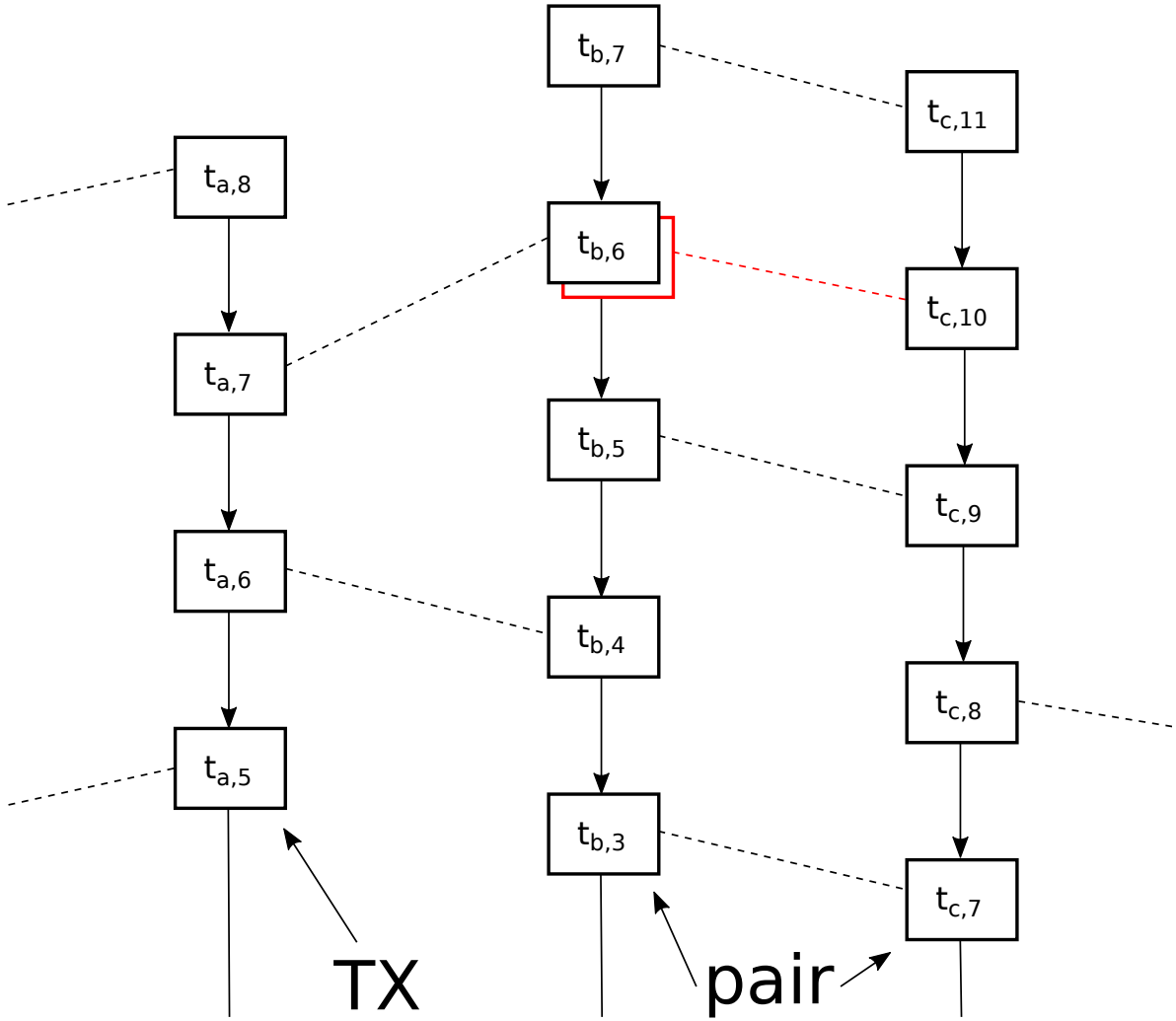


Figure: Fork is two correctly signed TX blocks that belong to the same sender and has the same hash pointer but involve different receivers. Only one TX block may be in consensus.

TrustChain

- Everyone has their own chain
- Transactions are on arbitrary data m
- Transactions are irrefutable due to hash pointers
- No consensus (my thesis)

Outline

TrustChain with Checkpoints

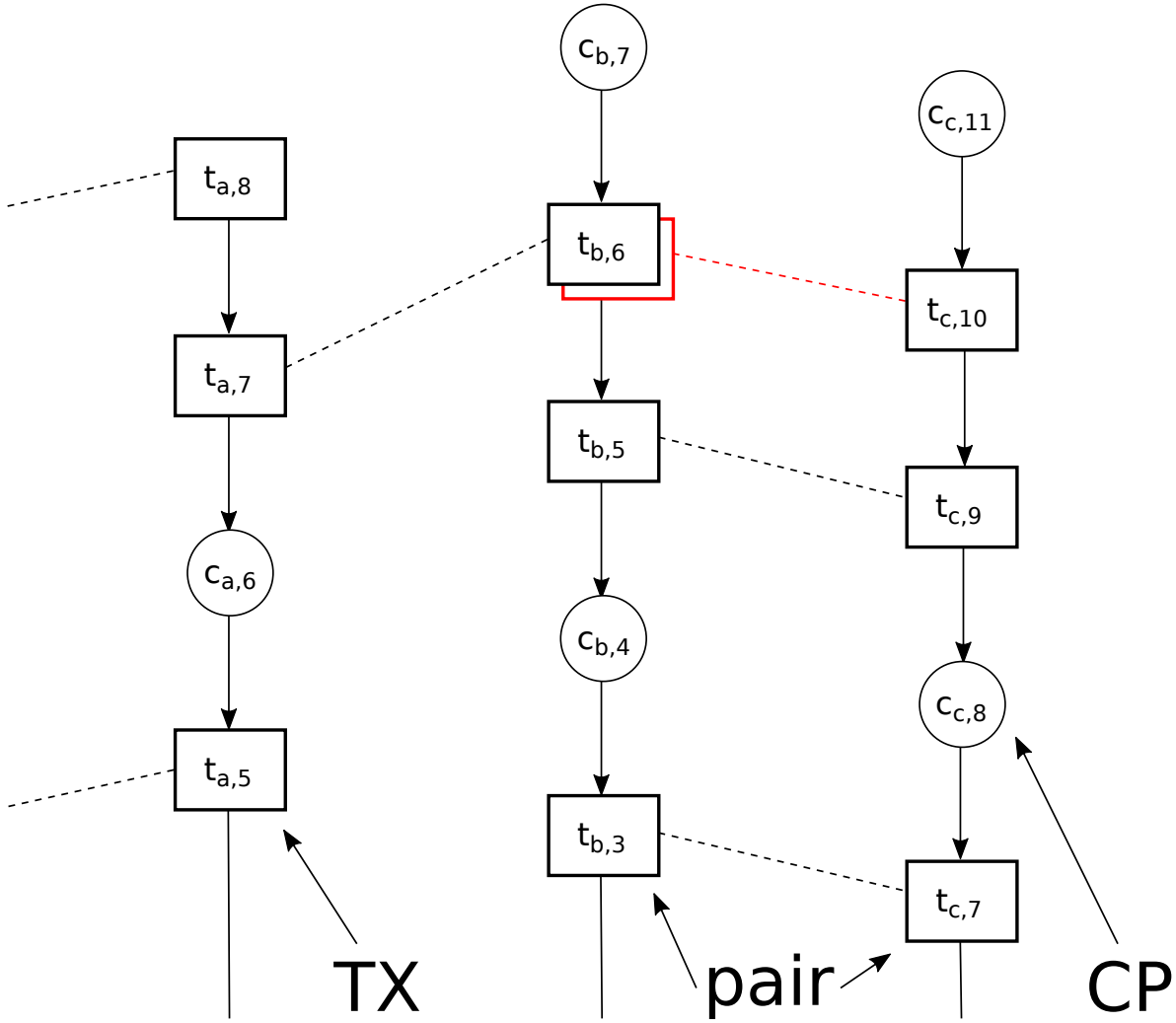


Figure: CP block is a six-tuple: $c_{i,j} = (\mathtt{h}(b_{i,j-1}), \mathtt{h}(\mathcal{C}_r), h, r, p, s)$, $\mathcal{C}_r$ is the consensus result at round r, p = promoter indicator, s = signature.

Outline

Protocol Overview

1. n lucky nodes are selected at random to act as promoters.
2. Promoters run a BFT (Byzantine Fault Tolerant) consensus algorithm to agree on a set of CP blocks.
3. Disseminate the consensus result (the CP blocks).
4. Repeat for next round.
5. Any interested node can validate that their transaction.

Outline

Promoter Registration

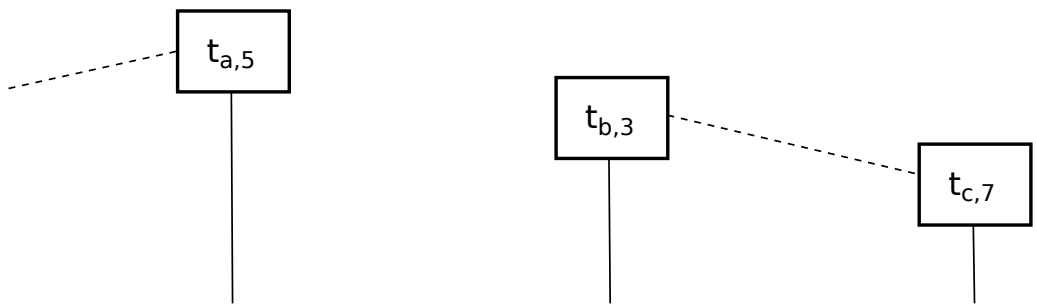


Figure: We start in the state where $\mathcal{C}_{r-1}$ has just been agreed but not yet propagated.

Promoter Registration

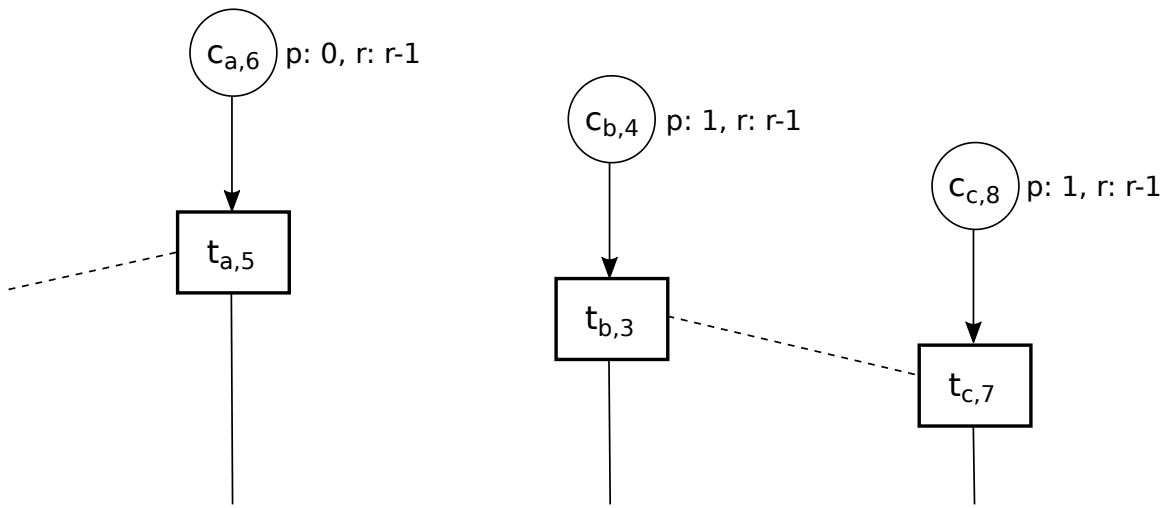


Figure: Nodes receive consensus result and set promoters indicator p, then send the new CP blocks to promoters of round r.

Promoter Registration

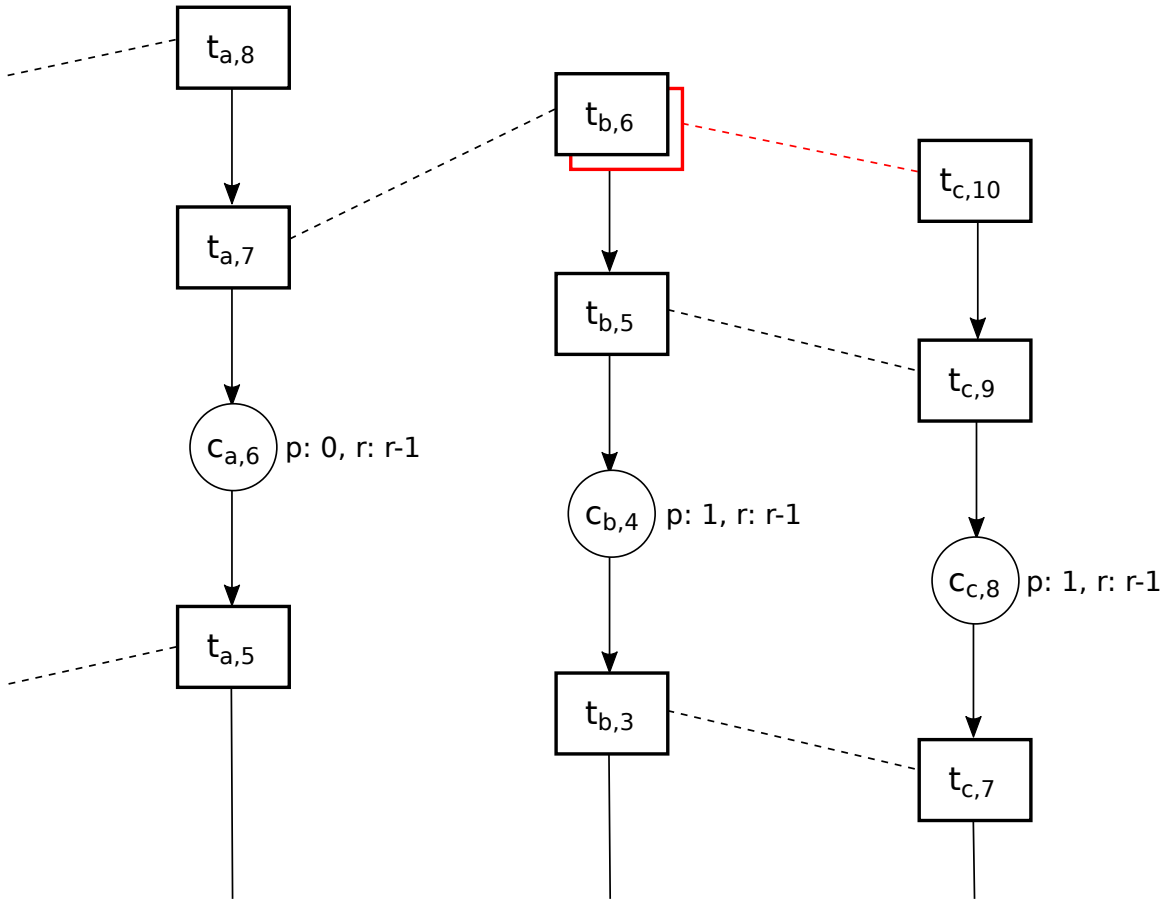


Figure: Transactions carry on as usual in round r. Note that our CP blocks (round $r-1$) has not reached consensus yet.

Promoter Registration

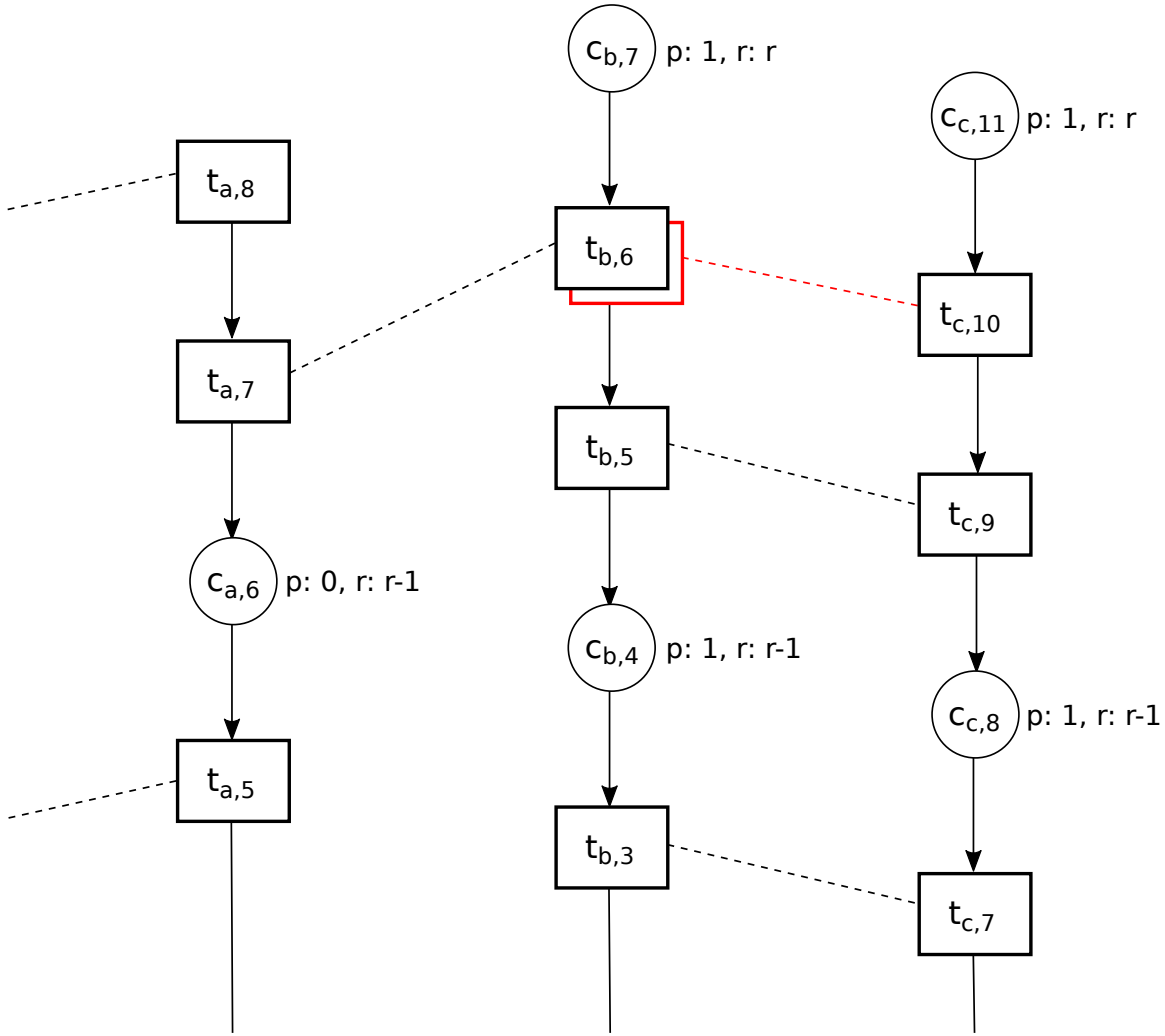


Figure: CP blocks at round $r-1$ should be in $\mathcal{C}_r$. If we're lucky: $\mathtt{h}(k_i||c_{i,j}) < T$, then we're responsible for consensus of round $r+1$.

Outline

Consensus

1. Nodes send CP blocks to the promoters.
2. The promoters' identities are encoded in the consensus result.
3. Promoters run the some asynchronous BFT consensus algorithm to agree on a set of CP blocks—$\mathcal{C}_r$.
4. $n \geq 3t + 1$ is the optimal for BFT consensus.
5. $\mathcal{C}_r$ and the signatures are disseminated.
6. Nodes create new CP blocks when they receive $t + 1$ good signatures and $\mathcal{C}_r$.

Theorem

Assuming the promoters satisfy $n \geq 3t + 1$. The promoter registration and the consensus protocol satisfies agreement, total order and liveness.

Outline

Validation

Assume node u is aware of all the past consensus results $\mathcal{C}_r$.
Suppose u wish to validate $t_{i,j}$. It performs the following.

1. Determine the pair $t_{i',j'}$.
2. Find the agreed enclosure for $t_{i,j}$ and $t_{i',j'}$ from $\mathcal{C}_r$, otherwise return "unknown".
3. Query i and i' for the agreed pieces and ensure hash pointers are correct. Otherwise return "unknown".
4. Check that $t_{i,j}$ and $t_{i',j'}$ are in the agreed pieces and are created correctly using `newtx`. Otherwise return "invalid".
5. Check the checkpoints $c_{i,k}$ and $c_{i',k'}$ that immediately follow $t_{i,j}$ and $t_{i',j'}$ are in the agreed pieces and are created in the same round, i.e. $\texttt{round}(c_{i,k}) = \texttt{round}(c_{i',k'})$. Otherwise return "invalid".
6. Return "valid".

Validation

In essence, given a TX, ask the receiver to proof that it has a set of transactions that produces some CP block, the CP block should be in the consensus result and the pair of the TX should be in that set.

Theorem

If at least one party of every transaction is honest, then forking and other forms of tampering is guaranteed to be detected if the malicious party is alive.

Question

Given a starting digest and an ending digest, is it possible for the prover to proof to the verifier that it has a set of blocks linked by hash pointers that "fits" inside those digests in *zero knowledge*.

Outline

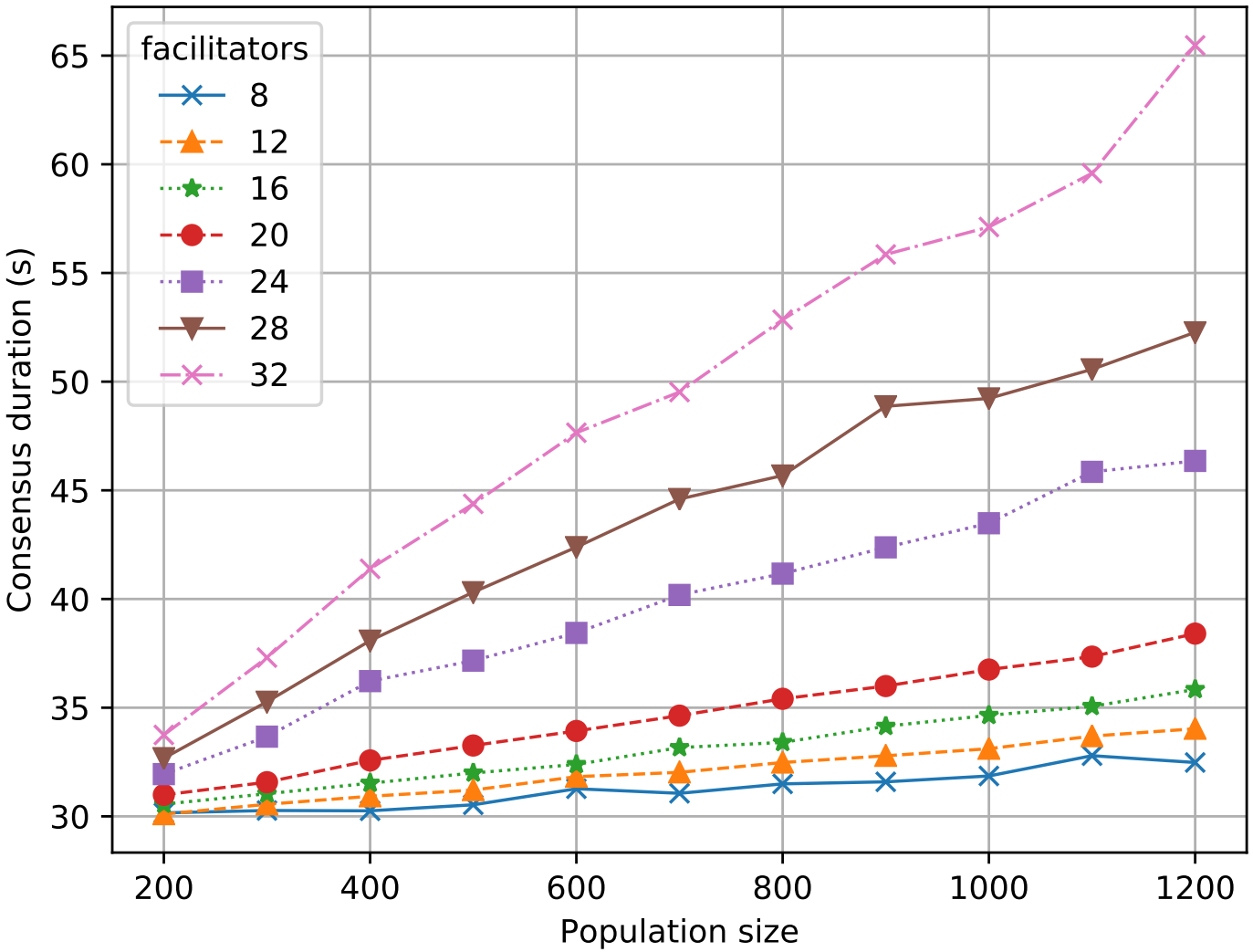
Implementation (4 weeks ago)

- Currently on going—using Python and Twisted
- Completed BFT consensus algorithm
- Completed local TrustChain with Checkpoints
- Next step is networked TrustChain and validation protocol

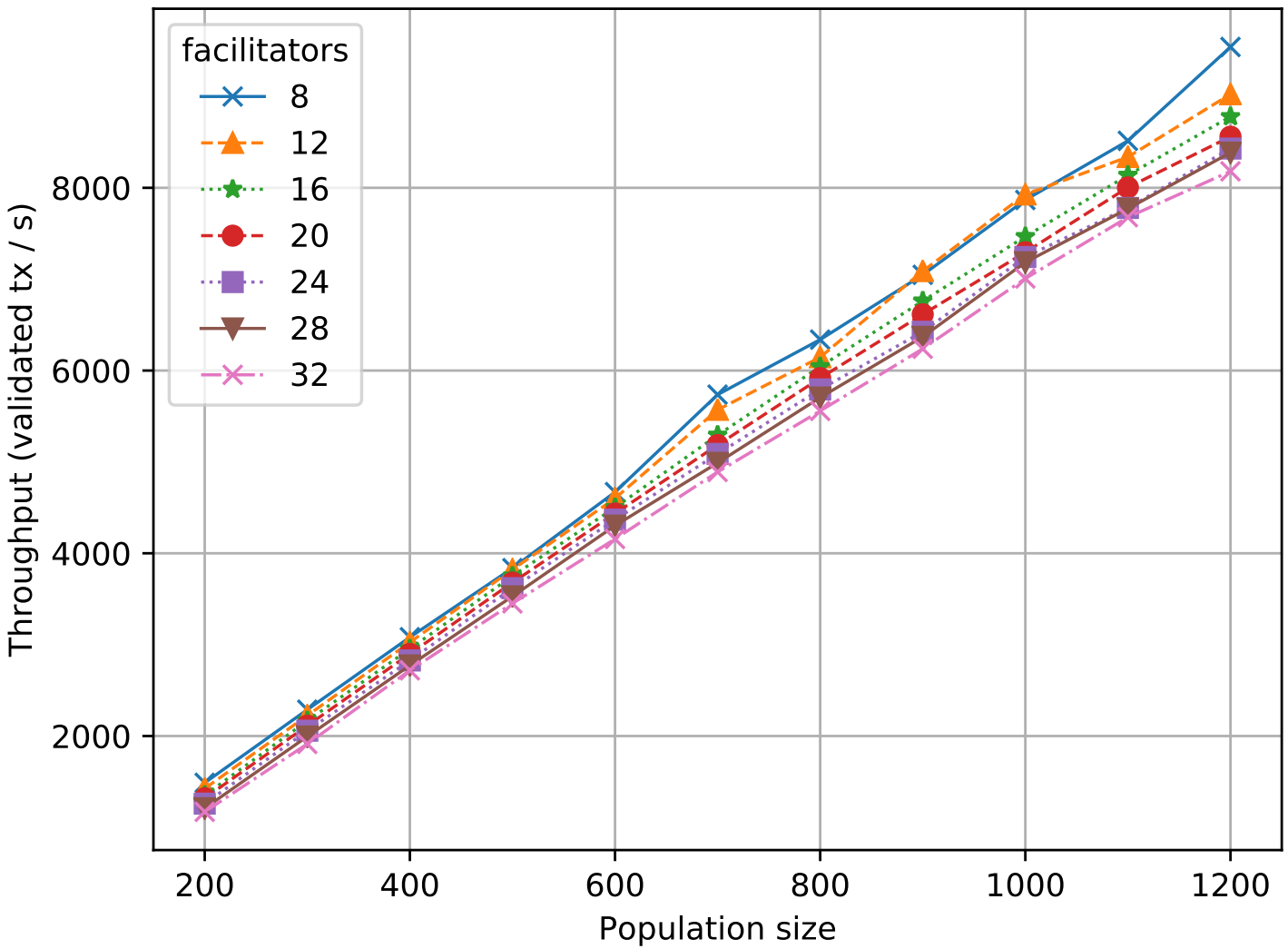
Implementation

- Completed BFT consensus algorithm, with erasure coding
- Completed TrustChain with Checkpoints, with experiments on DAS5
- Validation function is working
- Next step is to build validation into a network protocol and do experiments

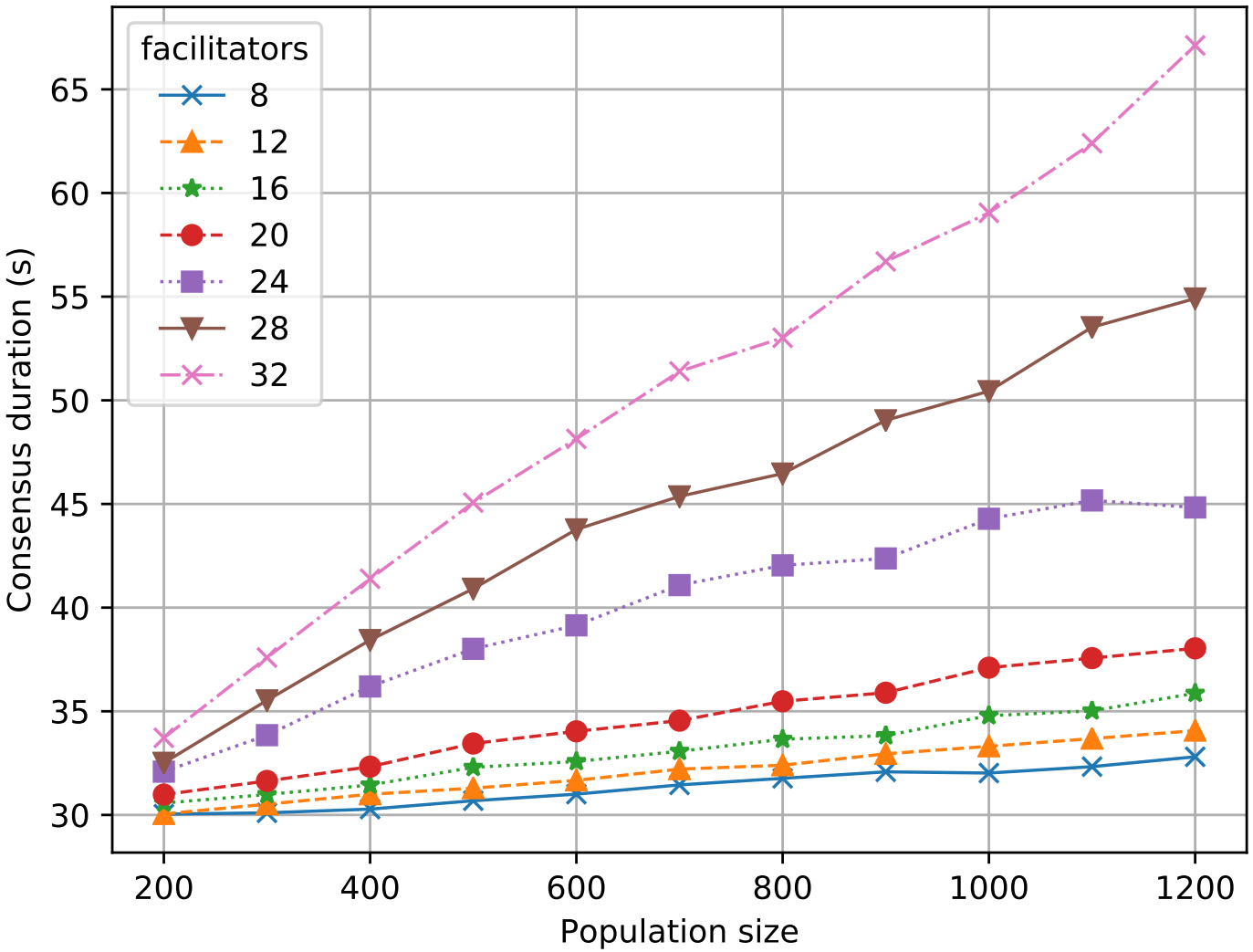
Consensus duration vs population size (static neighbour)



Throughput vs population size (static neighbour)



Consensus duration vs population size (random neighbour)



Throughput vs population size (random neighbour)