

# Presentation Title

## Optional Subtitle

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# Outline

## Background

- TrustChain

## My Thesis

- TrustChain with Checkpoints

- Protocol Overview

- Promoter Registration

- Consensus

- Validation

- Implementation

# Outline

## Background

TrustChain

## My Thesis

TrustChain with Checkpoints

Protocol Overview

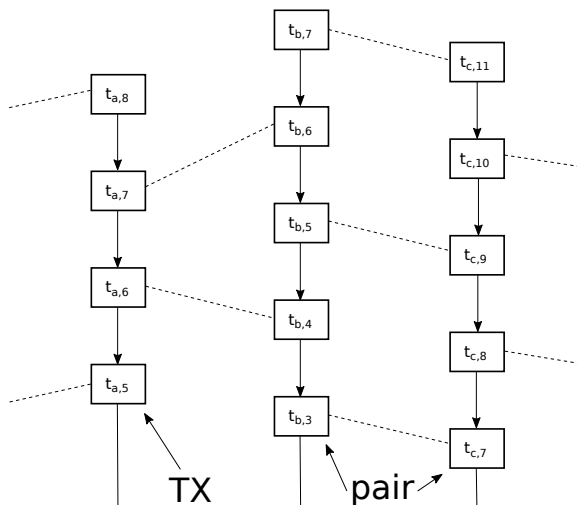
Promoter Registration

Consensus

Validation

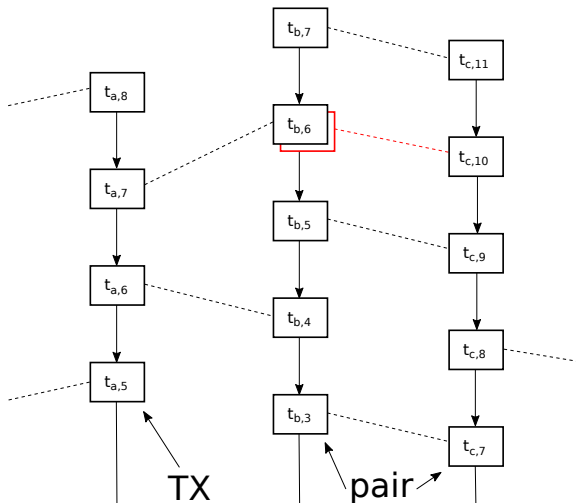
Implementation

# TrustChain



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

# TrustChain



**Figure:** Fork is two correctly signed TX blocks that has the same  $h_s$  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 make the chains intertwined
- ▶ Transactions are irrefutable due to hash pointers
- ▶ No consensus (my thesis)

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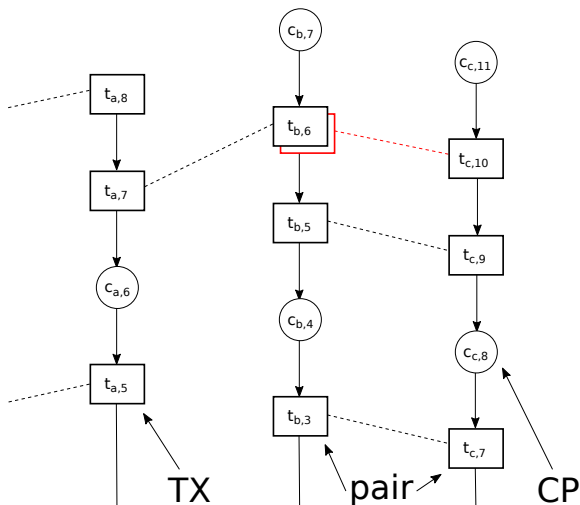
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# TrustChain with Checkpoints



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



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# 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.

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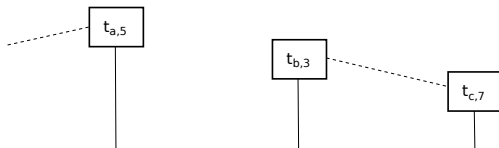
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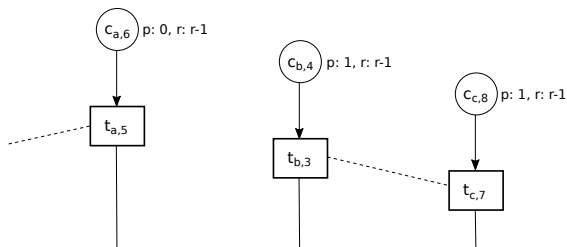
Implementation

# Promoter Registration



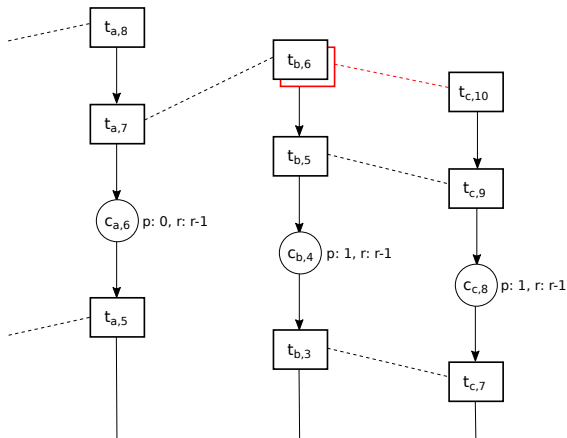
**Figure:** We start in the state where  $\mathcal{C}_{r-1}$  has just been agreed but not yet propagated.

# Promoter Registration



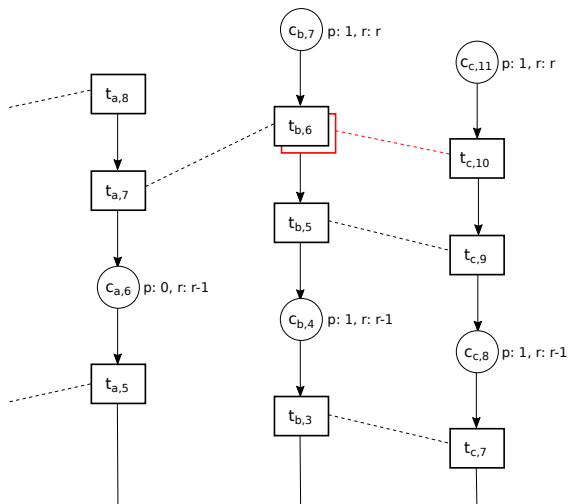
**Figure:** Nodes receive consensus result and set promoters indicator  $p$ , then send the new CP blocks to promoters of round  $r$ .

# 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:  $h(k_i || c_{i,j}) < T$ , then we're responsible for consensus of round  $r + 1$ .

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# Consensus

1. Nodes send CP blocks to the promoters.
2. The promoters' identities are encoded in the consensus result.
3. Promoters run the same asynchronous BFT consensus algorithm to agree on a set of CP blocks— $\mathcal{C}_r$ .
4.  $n = 3t + 1$  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  $n = 3t + 1$ . The promoter registration and the consensus protocol satisfied agreement, total order and liveness.*

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# 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.  $\text{round}(c_{i,k}) = \text{round}(c_{i',k'})$ . 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.*

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# Implementation

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