

A Modular Framework for Access Control on Cross-Chain transactions

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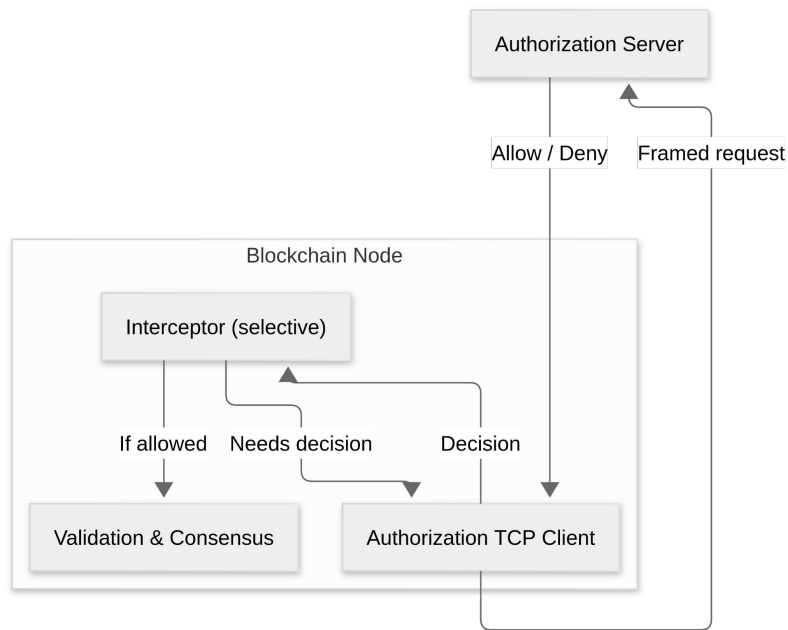
Motivations

- Cross-chain solutions are designed to ensure data integrity and state consistency across chains, but lack of an effective, transaction level access control
 - In general, every participant in a network can initiate transactions
- A trade-off is to implement it at smart contract level
 - Expensive, not modular, not re-usable

Major limitations

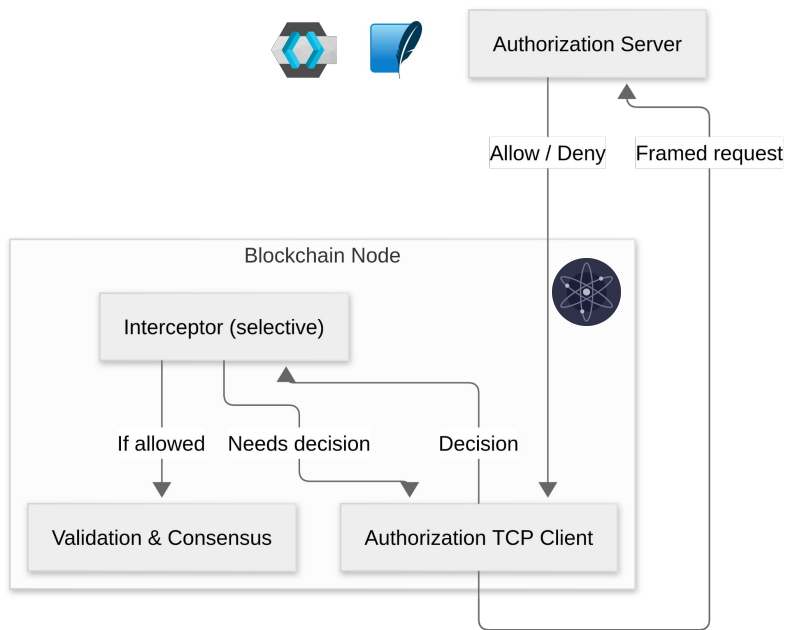
- **Limited control:** application business logic may require to reject cross-chain transactions according to the sender user's eligibility
- **Waste of computational effort:** transactions that should be rejected are processed even if they should not
- Smart contract-based access control increases the **complexity** of policy management (revocations, updates, etc..)

Proposed framework



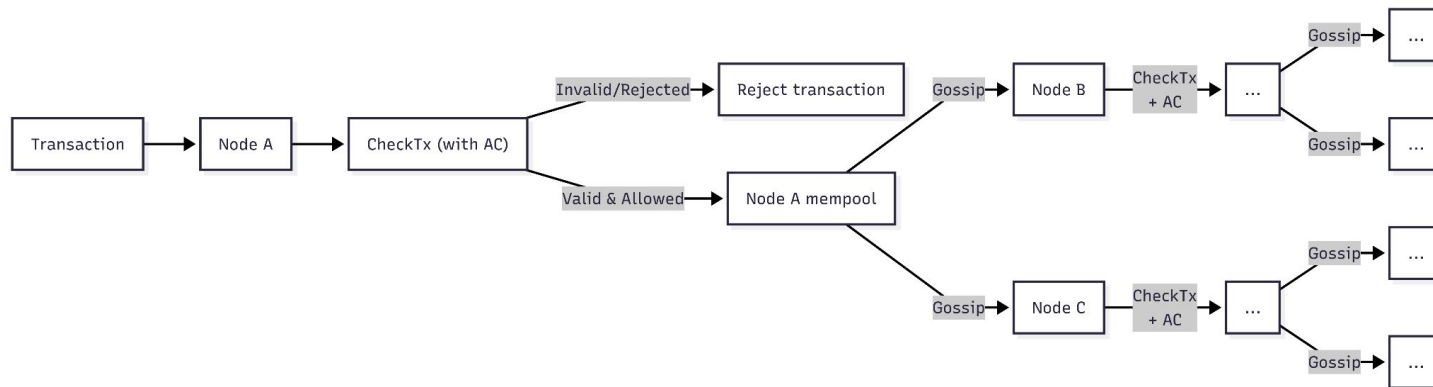
- **Transaction interceptor:** the component pre-processing transactions before validation
- **TCP client:** a lightweight connector integrated within the blockchain node
- **Authorization server:** enforces the policies

Prototype development



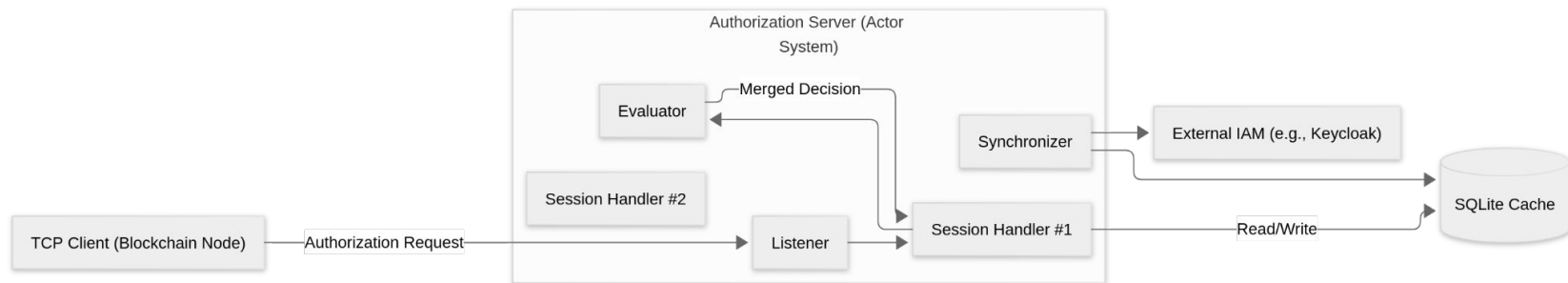
- **Blockchain:** Cosmos
 - Interceptor: AnteHandler
- **Authorization server:**
 - IAM: Keycloak
 - Cache: SQLite DB

Transaction processing



- Policies are enforced by the receiving node during CheckTx
- Mempool is gossiped to other nodes, which re-execute CheckTx by themselves
- In the end, every node checked all transactions, even before the consensus

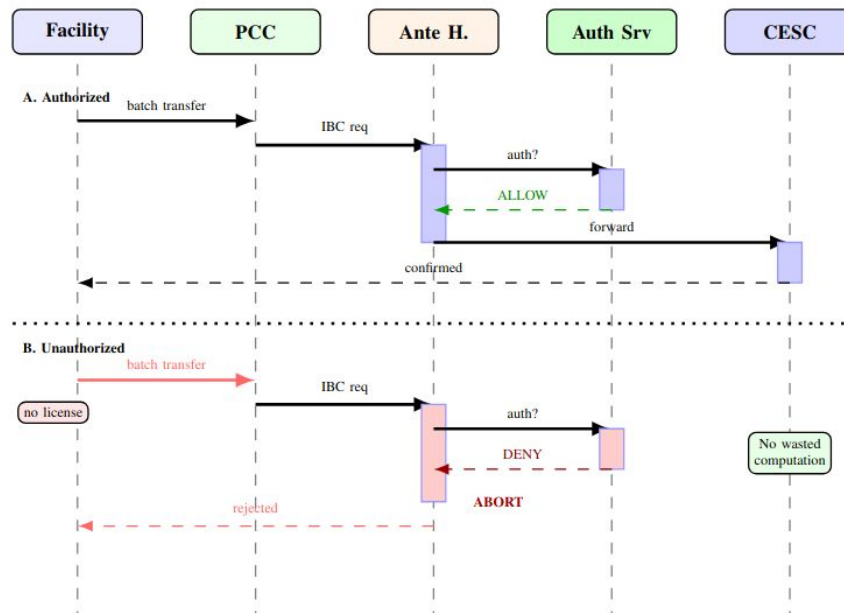
Policy evaluation



- The TCP client calls the authorization server passing context data
- A listener manages requests, handlers process the requests
- The server uses an external IAM and a cache to optimize attribute retrieval

Reference use case

- A facility wants to send a batch of plastic for recycling and get carbon credits
- The facility submits a transaction on the PCC chain which is forwarded to the CESC chain to collect credits
- The framework verifies the transaction and possibly forwards it according to the auth server decision



Reference use case - Trust model

- Waste management is a process regulated by recognised institutions and certification authorities
- A **governance** formed by these institutions solves several trust crucial issues:
 - It deploys operative blockchains, such that nodes are always trusted and guarantee external auditability
 - It manages the IAM, such that the policy enforcement process is guaranteed by institutional trust

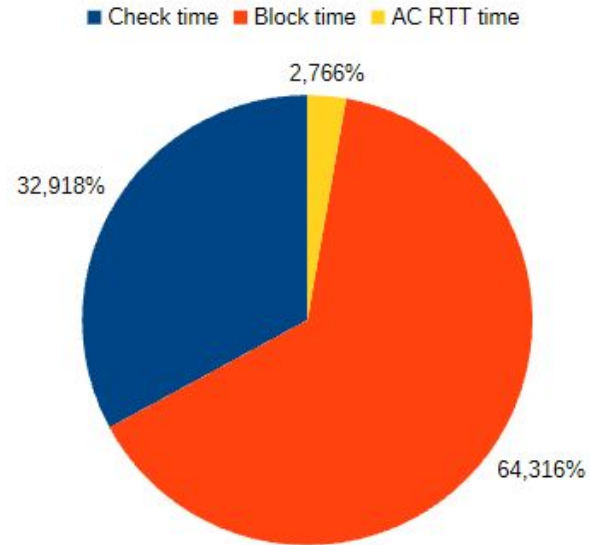
Gas consumption

- Smart contract based access control increases gas consumption
- For **permitted** transactions, the gas cost remains the same
- For **denied** transactions, the cost drops by 97% because the transaction is aborted before consuming the gas to process it

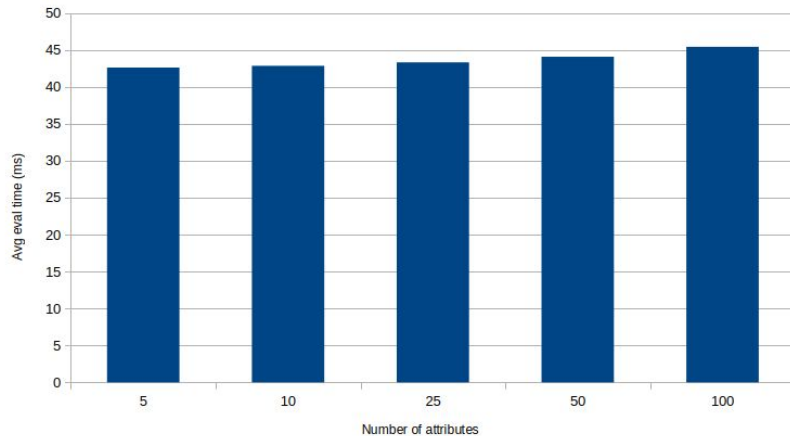
	Without AC	With smart contract AC	With AC framework
Permit	79.503	101.754	79.503
Deny		101.754	1.174

Transaction time breakdown

- **Check time:** time to verify transaction data/signatures (32.9%)
- **Block time:** block creation and transaction writing (64.3%)
- **AC RTT time:** time taken by access control policy enforcement (2.8%)

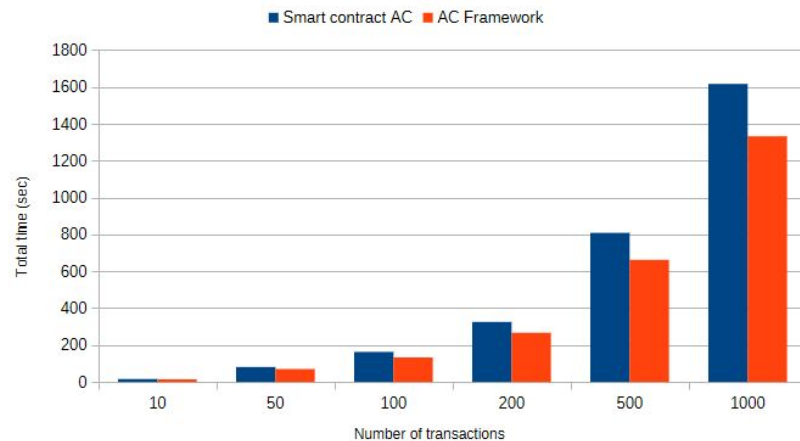


Experimental evaluations



Policy evaluation time
(similar despite numerous attributes)

Transaction batch processing
(90% permitted, 10% denied)
(10-18% faster)



Conclusions

- We showed how the lack of access control can be a critical issue for cross-chain transactions
 - We proposed a solution based on off-chain, real-time policy enforcement, with an implementation based on Cosmos
 - We presented the plastic waste management as a concrete use case where the adoption of our framework can be a significant improvement to existing solutions
 - Experimental evaluations prove the effectiveness of the proposal
 - **Ongoing work:** relax the trust model, expand the experimental setup
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Thank you for your attention



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