耐タンパー仮定に基づくオフライン・スマートコントラクト

Offline smart contract based on tamper resistance assumptions

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Blockchain has such disadvantages as high gas consumption during the execution and long latency to P2P transaction certification. To meet this challenge for blockchain as an execution architecture for smart-contracts, C. Raymond et al. (2019) proposed "Ekiden" as a technology to apply a trusted execution environment (TEE) to the blockchain. As Ekiden succeeds in reducing the calculation burden, it can process more smart-contracts in the same unit of time and resources. As a result, it can minimize the per-unit cost for the process and shorten latency. However, there is still a problem with introducing TEE, which this poster will discuss, as it takes a relatively long time to confirm that the internal state of TEE is securely stored in the blockchain as the blockchain fragment is used. This poster will assume a secure element (SE) of "Global Platform" specifications used in smartphones as tamper-resistant devices.

Outline

Problem : Disadvantages of smart-contract

Declining confidentiality and Performance.
⟹ Ekiden[1] proposed TEE & Block-chain technique.

Comparison items	Latency	Device	Improvement
Ekiden	**High**	**TEE**	**Confidentiality & Performance UP**
Proposal method	**Low**	**SE**	**Low Latency**

Comparison between proposal method and Ekiden.

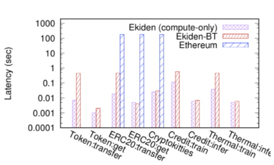


図 1: Latency[1]

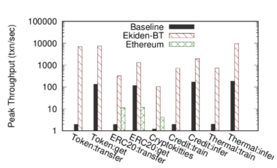
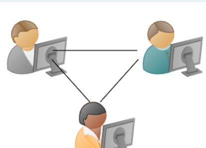


図 2: Throughput[1]

Problem

Block-chain

- As increase the amount of computation, gas-cost raises and be restricted feasible smart-contract.



Miners

Execute individually.

⟹ **Be restricted the feasible smart-contract.**

Goal

Goal of proposal method

- **Low latency**
  - Reduce the waiting time from settlement to contract execution (immediate execution).
- **Offline executable smart-contract**
  - Smart-contract temporarily runs offline and later connects online to expose the internal state.

Otimistic Proof of Publication

Definition (Publication)

An arbitrary string s is said to be publicized if and only if there exists a block satisfying the following:

$$^{\exists}B_i \in \mathcal{B}^{\lceil k} \quad s.t. \quad ^{\exists}\tau \in B_i \text{ and } s \in \tau$$

We write $s \in \mathcal{B}$ if s is publicized.

Work-flow

1. Player(Compute Node) gets a Token.
2. After SE check $s_{i-1} \in \mathbb{C}^{\lceil k}$, inputs Token and s_{i-1}.
3. SE decrypts s_{i-1} and updates the state. Verifier $\mathcal{V}$ sends s_i and Token.
4. Player registers the updated state with s_i as the state after the transition on the block-chain.
5. Send token to the next player.

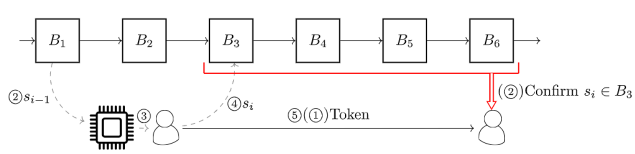
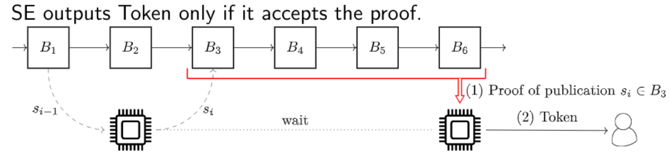


図 3: Optimistic Proof of Publication

Comparison for protocol

- **Proof of Publication[1]**
  SE checks to proof of publication $s_i \in B_3$.
  SE outputs Token only if it accepts the proof.



- **Optimistic Proof of Publication**
  SE output instantly Token.
  When receiver uses Token, receiver checks $s_i \in B_3$.