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Research Paper

DIGITALIZED AND DECENTRALIZED OPEN-CRY AUCTIONING: KEY PROPERTIES, SOLUTION DESIGN, AND IMPLEMENTATION

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ABSTRACT— Open-cry electronic auctions have revolutionized the landscape of high-value transactions for buying and selling goods. Online platforms such as eBay and Tradera have popularized these auctions due to their global accessibility and convenience. However, these centralized auctioning platforms rely on trust in a central entity to manage and control the processing of bids, e.g., the submission time and validity. The use of blockchain technologies for constructing decentralized systems has gained popularity for their versatility and useful properties toward decentralization. However, blockchain-based open-cry auctions, are sensitive to the order of transactions and deadlines which, in the absence of a governing party, need to be provided in the system design. In this paper, we identify the key properties for the development of decentralized open-cry auctioning systems, including verifiability, transaction immutability, ordering, and time synchronization. Three prominent blockchain platforms, namely, Ethereum, Hyperledger Fabric, and R3 Corda were analyzed in terms of their capabilities to ensure these properties for gap identification. We propose a solution design that addresses these key properties and presents a proof-of-concept (PoC) implementation of such design. Our PoC uses Hyperledger Fabric and mitigates the identified gaps related to the

time synchronization of this system by utilizing an external component. During the chaincode execution, the creation and submission of bids initiate requests to the time service API. This API service retrieves trusted timestamps from NTP services to obtain accurate bid times. We then analyzed the system design and implementation in the context of the identified key properties. Lastly, we conducted a performance evaluation of the time service and the PoC system implementation in time sensitive scenarios and assessed its overall performance.

Index Terms – Blockchain, open-cry electronic auctions, Ethereum, R3 Corda, smart contracts, bid ordering, time synchronization, trusted timestamps, NTP services, chaincode, verifiability, transaction immutability, performance evaluation.

I. INTRODUCTION

Electronic auctions are a popular way of buying and selling goods or services over the internet. They provide users with a platform on which to compete on iterative or sealed bidding processes to secure the best offer, usually over a specified time frame. The transition from traditional auctions, which take place in physical locations or using physical communication mechanisms is motivated by the growing adoption of digital technologies and Internet-based trading. Electronic auctions offer users a convenient way to engage in competitive bidding processes from anywhere, at any time, eliminating the constraints of physical presence, and enhancing their accessibility, scalability and transparency. This approach has made electronic auctions the preferred negotiation mechanism in industries such as consumer goods, automotive, real estate, and even government procurement. The transition from traditional auctioning to electronic systems comes however, with its own set of considerations, The integration of electronic auctions with decentralized systems has been proposed as an efficient way of addressing the aforementioned considerations. Blockchain technologies are often preferred over other distributed implementations for their properties toward decentralization, despite their trade-offs. Its decentralization ensures transaction transparency, tamper-proof records, and resistance to manipulation in a globally accessible system. Smart contracts, present in blockchain systems, facilitate the automatic execution of auction rules and transactions such as bid creation, validation and winner selection. Auctions can be divided into two

main types: Noniterative or sealed and iterative or open-cry. In noniterative auctions, participants submit their bids privately, often in sealed envelopes, and the highest bidder is awarded the item or service without knowledge of other bids. On the other hand, iterative auctions focus on open competition.

Here, participants make successive bids, with each bid being visible to all participants, and the auction continues until a condition is met. In the current state of the art (SotA) of blockchain-based auction systems, there is a predominant focus on noniterative bidding systems, i.e., double auctions and single-sided sealed bid auctions. However, in regard to open-cry (iterative) auction systems, the SotA is relatively limited in terms of research papers. In a previous survey work, we analyzed decentralized auctions as a whole and concluded blockchain systems to be a promising implementation choice. For this reason, we selected blockchain as the core of this paper. Some of the main issues in open-cry decentralized auctions relate to the validity of the entries and transactions and determine the correct order of the transactions and the time these were created. The issue of accurate time synchronization is a common issue present in several decentralized systems. The most common way to allow nodes to synchronize on time is to give up some degree of decentralization by relying on a time reference provided by a centralized system. This time reference can be either an external source or a singular node which has the authority to provide its time as a reference to other nodes. Blockchain systems frequently encounter limitations in concurrent transaction processing. As a result, they introduce various mechanisms for serializing transactions instead of processing them in parallel. However, in the context of an open-cry auction implementation, this serialization process can potentially compromise the overall perception of correctness. Therefore, it is essential to identify blockchain approaches that effectively address the key properties of decentralized auction systems. In cases where existing solutions present limitations, especially in the context of transaction ordering and time synchronization, it is crucial to support the implementation of the needed features to fulfill these properties.

II. RELATED WORK

A. Deterministic concurrency control for private blockchains

Private blockchain has gained popularity in inter-organization business processing It allows mutually untrusted parties to share

data and mutate data in an endorsed manner. A typical private blockchain is composed of a consensus layer pipelined with an execution layer, where the organizations agree on the blocks of transactions using the consensus layer and the transaction blocks are then passed to each organization's executor for execution. To ensure the organizations share an identical view of data, one core requirement of the executor is determinism, i.e., given the same transaction blocks and the same initial state, the executors must produce an identical new state. While the consensus layer was regarded to be the major bottleneck of the blockchains, the relaxed requirement in the interorganization setting enables recent optimizations to achieve astonishingly good performance, which in turn shifts the bottleneck to the execution layer. However, even the latest research in private blockchain offers unsatisfactory throughput in the execution layer due to the requirement of determinism. That's because determinism limits the parallelism of execution since parallel execution often results in non deterministic execution order. Therefore, recent works cannot execute transactions with full concurrency. In this paper, we present Harmony, a deterministic concurrency control algorithm that is highly concurrent and yields 2.0 × to 3.5 × better throughput over the state-of-the-art competitors. Harmony is built on the shoulder of the latest deterministic databases] that optimize concurrency control while upholding determinism. Based on that, Harmony incorporates inter block parallelism and judicious abort which is crucial for performance in blockchain setting.

B. Research on blockchain-based Ebidding system

In the field of modern bidding, electronic bidding leads a new trend of development, convenience and efficiency and other significant advantages effectively promote the reform and innovation of China's bidding field. Nowadays, most systems require a strong and trusted third party to guarantee the integrity and security of the system. However, with the development of blockchain technology and the rise of privacy protection, researchers has begun to emphasize the core concept of decentralization. This paper introduces a decentralized electronic bidding system based on blockchain and smart contract. The system uses blockchain to replace the traditional database and uses chaincode to process business logic. In data interaction, encryption techniques such as zero-knowledge proof based on graph isomorphism are used to improve privacy

protection, which improves the anonymity of participants, the privacy of data transmission, and the traceability and verifiable of data. Compared with other electronic bidding systems, this system is more secure and efficient, and has the nature of anonymous operation, which fully protects the privacy information in the bidding process. Blockchain is a decentralized public ledger based on P2P networks, which has attracted wide attention in distributed application systems in recent years. In this technology, a tamper-resistant digital platform for data storage and sharing is realized by applying the chain-block structure and establishing a trusted consensus mechanism to synchronize data changes.

At the same time, the decentralization, traceability and immutability of on-chain information storage makes blockchain a trusted machine with high reliability and security. Based on these characteristics, researchers began to analyze the application of blockchain in various fields, such as the Internet of Things, supply chain management, voting system and bidding system.

C. A blockchain-based iterative double auction protocol using multiparty state channels

Although the iterative double auction has been widely used in many different applications, one of the major problems in its current implementations is that they rely on a trusted third party to handle the auction process. This imposes the risk of single point of failures, monopoly, and bribery. In this article, we aim to tackle this problem by proposing a novel decentralized and trustless framework for iterative double auction based on blockchain. Our design adopts the smart contract and state channel technologies to enable a double auction process among parties that do not need to trust each other, while minimizing the blockchain transactions. In specific, we propose an extension to the original concept of state channels that can support multiparty computation. Then, we provide a formal development of the proposed framework and prove the security of our design against adversaries. Finally, we develop a proof-of-concept implementation of our framework using Elixir and Solidity, on which we conduct various experiments to demonstrate its feasibility and practicality.

D. Peer-to-peer energy trading in smart grid through blockchain: A double auction-based game theoretic approach

In a smart grid, each residential unit with renewable energy sources can trade energy

with others for profit. Buyers with insufficient energy meet their demand by buying the required energy from other houses with surplus energy. However, they will not be willing to engage in the trade if it is not beneficial. With the aim of improving participants' profits and reducing the impacts on the grid, we study a peer-to-peer (P2P) energy trading system among prosumers using a double auction-based game theoretic approach, where the buyer adjusts the amount of energy to buy according to varying electricity price in order to maximize benefit, the auctioneer controls the game, and the seller does not participate in the game but finally achieves the maximum social welfare. The proposed method not only benefits the participants but also hides their information, such as their bids and asks, for privacy. We further study individual rationality and incentive compatibility properties in the proposed method's auction process at the game's unique Stackelberg equilibrium. For practical applicability, we implement our proposed energy trading system using blockchain technology to show the feasibility of real-time P2P trading. Finally, simulation results under different scenarios demonstrate the effectiveness of the proposed method.

III. PROPOSED METHODOLOGY

To address the limitations of existing systems, we propose a decentralized open-cry auction framework leveraging blockchain technology, specifically Hyperledger Fabric. Our proposed system incorporates a novel algorithm that enhances key properties such as verifiability immutability, ordering, and time synchronization. Bidders submit their bids through a decentralized application (DApp). Each bid is validated against the auction parameters (e.g., minimum increments and deadlines). Upon bid submission, a request is sent to an external time service API that retrieves accurate timestamps from NTP services, ensuring the validity of the bid's timing. At the auction's conclusion, the highest bid is determined based on the immutable records, and the auction is finalized automatically through smart contracts, releasing the item to the winning bidder.

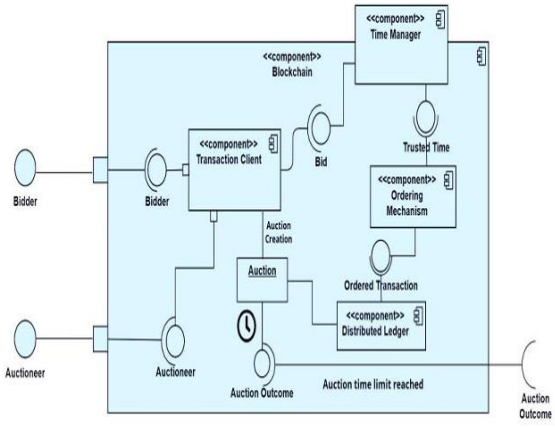


Fig. 1: System Overview

3.1 User Interface Design

In this module we design the windows for the project. These windows are used for secure login for all users. To connect with server user must give their username and password then only they can able to connect the server. If the user already exits directly can login into the server else user must register their details such as username, password and Email id, into the server. Server will create the account for the entire user to maintain upload and download rate. Name will be set as user id. Logging in is usually used to enter a specific page.

3.2 Seller

The second module is a seller. The purpose of a seller in an auction, whether traditional or electronic, is to offer goods or services for sale to potential buyers in a competitive environment.

3.3 Auctioneer

The purpose of an auctioneer is to facilitate the sale of goods or services by managing the bidding process. They conduct the auction by announcing items, setting starting bids, and encouraging bidder participation, all while ensuring a fair and transparent environment.

3.4 Buyer

The purpose of a buyer in an auction is to acquire goods or services at a competitive price. Buyers participate in the bidding process to secure items that meet their needs or desires, whether for personal use, investment, or resale. They aim to achieve the best possible deal, leveraging competition among bidders to potentially high costs.

3.5 Admin

Admin has a fifth module. Admin has a login with a user id and password. Admin has a Stored data in the database. Admin controls all this data from database, here admin store every operation of an user. We can see here file details and user details.

IV. EXPERIMENTAL RESULTS AND ANALYSIS

The proposed decentralized open-cry auction system was implemented using Hyperledger Fabric with an external time service API to ensure trusted timestamp generation. The experimental results showed that the system can accurately record bid submission times and maintain proper bid ordering in time-sensitive auction scenarios. It also preserved important blockchain properties such as verifiability, immutability, and transparency. The integration of NTP-based timestamp support improved deadline enforcement and

reduced synchronization issues. Although the external time service added slight processing overhead, the overall system performance remained stable and effective for secure decentralized auction operations.

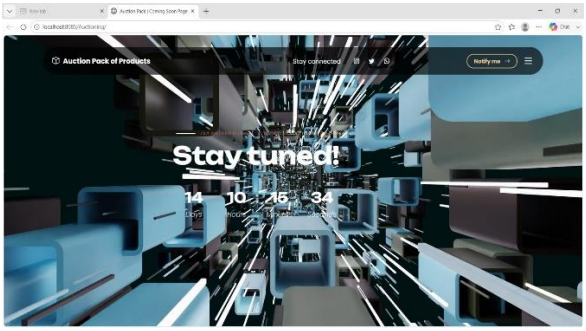


Fig. 2: Home Page

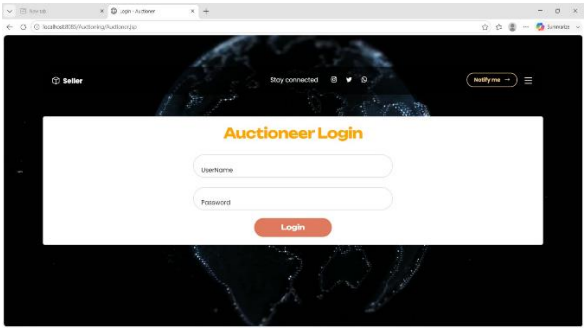


Fig. 3: Login

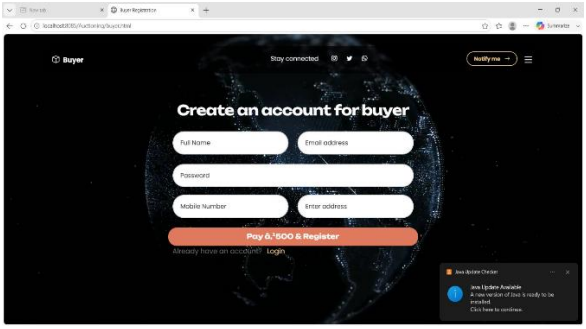


Fig. 4: Create Account

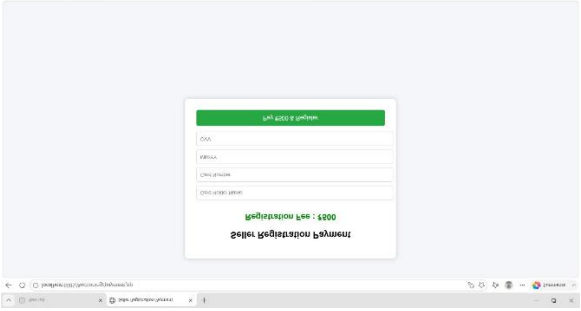


Fig. 5: Seller Registration

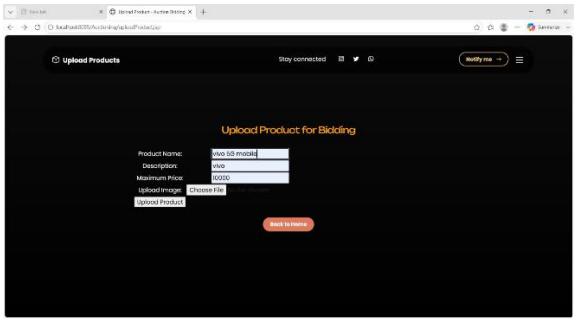


Fig. 6: Upload Product

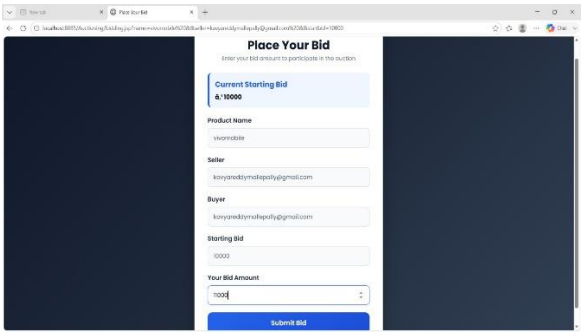


Fig. 6: Enter Bid Amount

V. CONCLUSION

This paper has focused on the analysis of key properties for decentralized electronic auctions. Subsequently, we identified the necessary components to be implemented in a proof-of-concept to fulfill these properties. The different systems address the identified properties in different ways, however, they

need to be complemented by additional features to fulfil such properties. A qualitative and quantitative evaluation was conducted on the entire Block chain system, as well as on the external time service in isolation.

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