WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Revolutionizing Open-Cry Auctions: A Blockchain-Based Digital and Decentralized Approach

Md. Khizer Mohinuddin[1], Ambadi Narendra[2], Harsha Vardhan[3], M. Sai Kumar[4], Mr. Suyash Agrawal[5]

[1,2,3,4]Computer Science and Engineering (Internet of Things), Guru Nanak Institutions Technical Campus, Telangana, India

[5]Asst. Professor, Computer Science and Engineering (Internet of Things), Guru Nanak Institutions Technical Campus, Telangana, India

[1]khizermd2003@gmail.com, [2]narendraambadi677@gmail.com, [3]harshavardhan933@gmail.com, [4]meesalasaikumar1724@gmail.com, [5]Suyash.agrawal1983@gmail.com

ABSTRACT

Open-cry electronic auctions have transformed high-value transactions, with platforms like eBay and Tradera offering global reach and convenience. However, these systems rely on centralized authorities to validate bids and manage submission times. Blockchain technology offers decentralized alternatives, but challenges such as transaction ordering and time synchronization must be addressed in the absence of a central party. This paper outlines essential properties for decentralized open-cry auctions—verifiability, immutability, ordering, and timing. We evaluate Ethereum, Hyperledger Fabric, and R3 Corda, and propose a Hyperledger Fabric-based proof-of-concept that integrates an external time service using NTP to ensure accurate, trusted bid timestamps.

KEY WORDS: ***Decentralized auction, Open-cry bidding, Blockchain, Hyperledger Fabric, Time synchronization, Verifiability, Immutability, Smart contracts, Transaction ordering, NTP, Proof-of-concept, Distributed ledger, Bid validation, Auction transparency, Performance evaluation.***

I.INTRODUCTION

Electronic auctions have become a widely adopted method for buying and selling goods or services online, offering convenience, accessibility, and scalability. Unlike traditional auctions requiring physical presence, electronic auctions enable users to participate from anywhere, making them ideal for sectors like consumer goods, real estate, and government procurement. With the rise of digital technologies, integrating electronic auctions with decentralized systems—particularly blockchain—has gained traction due to blockchain's transparency, immutability, and resistance to manipulation. Smart contracts on blockchain platforms automate core auction processes like bid creation and winner selection. While most blockchain-based auction research has focused on sealed (noniterative) bidding models, iterative or open-cry auctions have received limited attention. These systems face unique challenges, especially in ensuring valid transaction ordering and precise time synchronization. As decentralization complicates synchronized timing, many systems rely on centralized time references, which reintroduce central trust. This paper focuses on addressing these challenges to enhance the integrity and fairness of decentralized open-cry auctions.

II. FOUNDATIONS OF ELECTRINIC AUCTIONING

Traditional auctions are typically held in physical settings and managed by auctioneers who oversee the entire process. With the advent of digital technologies, these auctions have evolved to operate across time and space, significantly enhancing transaction accessibility. Centralized platforms like eBay and Tradera manage key aspects such as transaction validity, bid ordering, and submission times, but this control depends on a trusted central authority. In decentralized environments, alternative mechanisms are required to ensure these features while maintaining the core benefits of decentralization.

A. Quality Attributes for Electronic Auctions

To ensure trust and integrity in decentralized electronic auctions, several quality attributes must be embedded in system design. These include:

Correctness: Ensures auction rules are executed accurately, allocating resources to the highest-valuing bidder.

Nonrepudiation: Once submitted, a bid cannot be denied or retracted.

Transparency: All participants must be able to independently verify outcomes.

Security: Protection against manipulation or interference from malicious actors is essential.

Scalability: The system must handle multiple auctions concurrently without performance loss.

B. Electronic Open-Cry Auctioning

Open-cry auctions offer real-time, transparent bidding that fosters competition and informed decision-making—ideal for high-value transactions. In centralized systems, the platform determines bid order and identifies winners. In decentralized systems, however, this requires designing secure, reliable mechanisms for transaction sequencing. Moreover, for auctions with strict deadlines, precise time synchronization between participants is crucial. This guarantees a unified understanding of time-sensitive events, ensuring fairness and consistency across the decentralized auction process.

III. KEY PROPERTIES FOR DECENTRALIZED AUCTIONING

Here's a simpler version of the key properties for decentralized auction systems:

A.Verifiability

In a decentralized auction system, it's important to make sure that all transactions are valid and that the auction rules are followed. Verifiability means participants can check if everything was done correctly, which builds trust in the system.

B. Transaction Immutability

Once a bid or transaction is verified in a decentralized auction, it should not be changed. This makes the process more trustworthy. It's also important that no one has an advantage by having extra information, so everyone has equal access to the auction details.

C. Transaction Ordering

In decentralized auctions, there's no single person (like an auctioneer) deciding the order of bids. Instead, the system uses a method to agree on the order. This is important because if multiple bids come in at the same time, the order in which they are processed determines the winner.

D. Time Synchronization

In traditional auctions, the auctioneer controls the timing. But in decentralized systems, we need to make sure that everyone agrees on when the auction ends. Some systems extend the deadline if bids are placed close to the end. This helps reduce the need for perfect timing, but if the time is fixed, it's crucial to ensure that everyone's clocks are in sync.

E. Performance

A good auction system should work smoothly and handle a lot of users without delays. In decentralized systems, how fast the system can process transactions depends on factors like block size and the method used to agree on transactions. Larger blocks can process more bids but can also slow down the system. Performance depends on how well the system handles transaction order and timing.

IV. BLOCKCHAIN SYSTEMS

This section provides an overview of blockchain technology, categorizing it by levels of anonymity, and examines popular blockchain frameworks for electronic open-cry auctions. It also analyzes the current state of auction systems built on these frameworks, identifying the most suitable one for our Proof of Concept (PoC) implementation.

A. Blockchain Primer

Blockchain is a distributed ledger that records digital transactions without central authority, using a public ledger and consensus protocols for trust. There are two main types of blockchain:

Permissionless Blockchains like Bitcoin allow anyone to join and view transactions, offering pseudonymous identities.

Permissioned Blockchains like Hyperledger Fabric and R3 Corda require user identification, providing more control over access and data security.

B. Blockchain Tradeoffs

Blockchain and smart contracts can improve centralized auction models by ensuring decentralization, transparency, and trust. However, balancing anonymity and identity management is crucial, especially for high-value auctions. Smart contracts are immutable and enforce agreements, but there are tradeoffs in decentralization, security, and scalability.

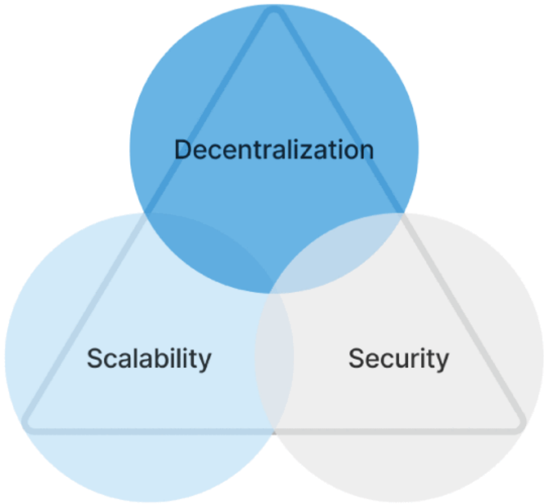


FIGURE 1.

Blockchain trilemma: only two of decentralization, scalability, and security can be fully achieved.

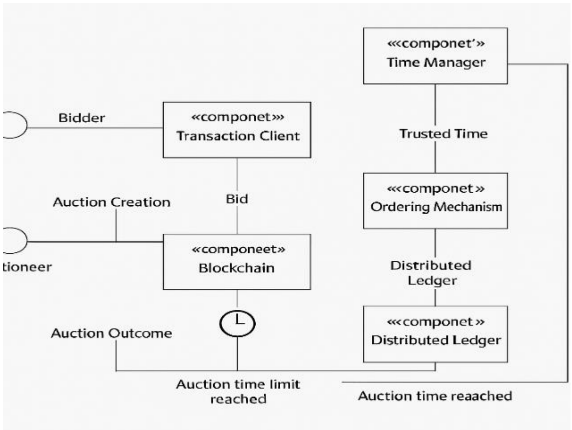


FIGURE 2.

Component diagram of the proposed system architecture.

C. Popular Blockchain Frameworks

Ethereum: A permissionless blockchain that supports smart contracts using Proof of Stake (PoS) and Ether for transactions.

Hyperledger Fabric: A permissioned blockchain for enterprise use, offering a secure, private network for transactions with smart contracts called "chaincode."

R3 Corda: A permissioned blockchain focused on privacy, ideal for financial transactions, using Ricardian contracts for legal agreements.

D. Verifiability and Immutability

All blockchain frameworks ensure verifiability and immutability of transactions, which is vital for decentralized applications like auctions.

E. Transaction Ordering

Different blockchains handle transaction ordering in various ways. Ethereum uses Proof of Stake, R3 Corda uses notary pools, and Hyperledger Fabric uses consensus mechanisms like Raft. However, none support concurrency well.

F.TimeSynchronization

Time synchronization is a challenge in decentralized systems. Ethereum struggles with syncing block creation times, while R3 Corda uses time windows, and Hyperledger Fabric relies on synchronized clocks but lacks a trusted time source.

G.Performance

Hyperledger Fabric outperforms Ethereum in terms of latency and throughput, making it more suitable for fast-paced auction environments. However, latency remains a challenge even for Hyperledger Fabric in highly competitive settings.

V. STRATEGY AND EXECUTION OF THE SOLUTION

This section outlines the decentralized auction system design, followed by a PoC implementation using Hyperledger Fabric, complemented by additional components to address gaps from Section IV.

A. Proposed statement:

This project addresses the limitations of traditional centralized auction platforms, which depend on a governing entity to manage bid submissions and ensure transaction integrity. Such centralization raises concerns about transparency, security, and fairness, especially in high-value transactions. Additionally, existing blockchain-based auction systems face challenges related to transaction order and the accurate tracking of bid submission times, both crucial for a fair auction process. Without a central authority to enforce these aspects, decentralized solutions struggle with issues like verifiability, transaction immutability, and time synchronization. The goal of this project is to identify and resolve these gaps, ultimately developing a reliable decentralized open-cry auction system that offers the same level of trust and efficiency as traditional platforms while leveraging the advantages of blockchain technology.

B. Proof of Concept Development:

For this proof-of-concept, Hyperledger Fabric was chosen for its robust blockchain capabilities, enabling the automation of auction rules via smart contracts. It effectively addresses several key properties, including verifiability, transaction immutability, and performance. However, certain challenges remain, particularly with time synchronization. Hyperledger Fabric's ordering service ensures that bids arriving simultaneously with similar timestamps are correctly ordered, helping to maintain the integrity and fairness of the auction process, especially when strict deadlines are in place..

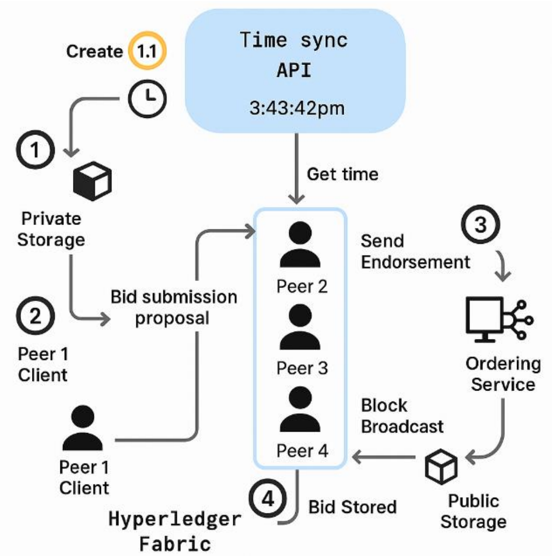


FIGURE 3.

Illustration of the components within the proof-of-concept system architecture.

1) AuctionLogic:

The proposed solution includes three smart contracts:

Create Auction: Executed by the auction owner to initialize an auction with a time limit.

Create Bid: Executed by non-owners to generate a private bid with an ID and price. It sends a POST request to an external API for trusted timestamps. Requires only single-party endorsement, allowing concurrent execution.

Submit Bid: References a created bid, requires endorsement from all involved peers. Sends a GET request to retrieve timestamps, then uses a txID-based hash to shuffle and select a trusted timestamp.

2) ExternalModule:

An external Flask API, deployed within a Docker container, is integral to the system's time-tracking mechanism. When a bid is created, this API registers timestamps from multiple NTP servers, providing a trusted record of the bid's initiation time. These timestamps are crucial for ensuring fairness and accuracy in the bidding process. During bid submission, peers send GET requests to the API to retrieve the previously recorded timestamps. This validation step helps confirm the authenticity and timing of each bid. The use of external, verifiable time sources enhances the system's integrity.

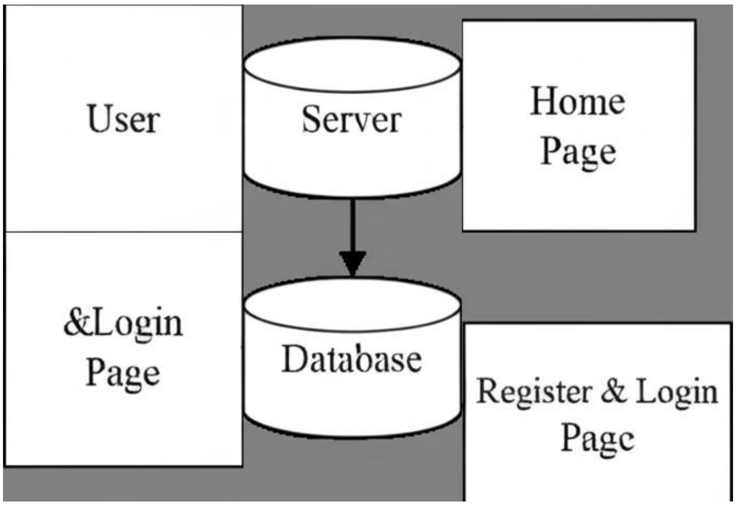
3)Implementation Considerations:

The Hyperledger Fabric framework offers basic blockchain functionalities, providing security through a permissioned blockchain where authorized users can interact securely. All transactions are recorded in the blockchain, visible to enrolled network members. For time synchronization, we incorporate an external element, as Hyperledger Fabric's concurrency management, which relies on locks or serialization, limits accurate timestamping. Concurrent bids are processed sequentially, causing timestamps to potentially misrepresent submission times. To address this, Hyperledger Fabric uses an ordering service that delegates transaction ordering from peers to a consensus-based system, ensuring the correct sequence of transactions rather than ordering solely by time.

VI. METHODOLOGIES

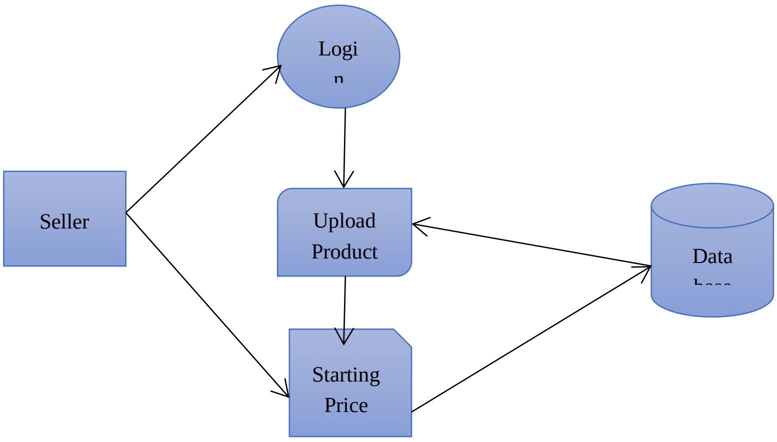
1. User Interface Design:

This module creates secure login windows. Users log in with a username and password. If the user doesn't exist, they register with their details. The server creates accounts to manage upload/download rates, with the username as the user ID. Logging in grants access to specific pages.



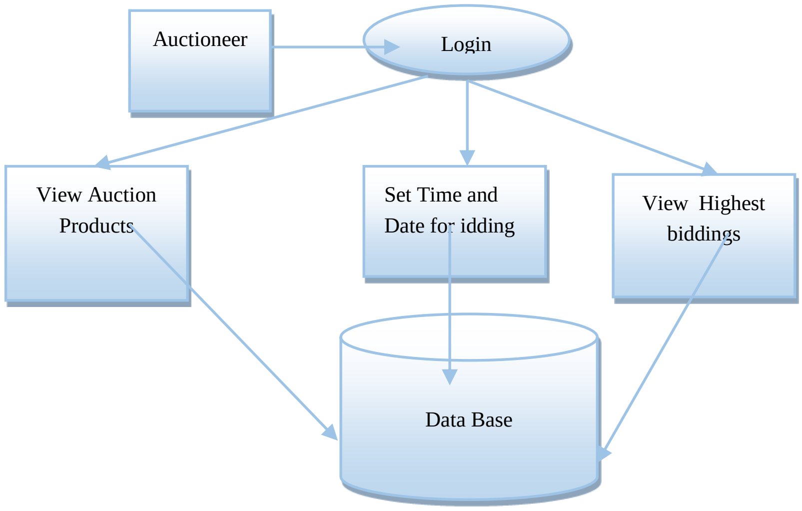
2. Seller

The second module is the seller. In both traditional and electronic auctions, the seller's role is to offer goods or services for sale to potential buyers in a competitive setting.



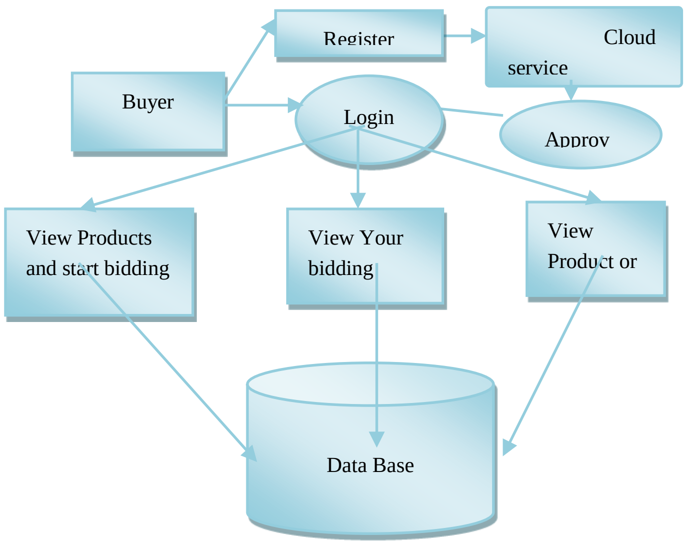
3. Auctioneer

The auctioneer's role is to oversee the sale of goods or services by managing the bidding process. They announce each item, set starting bids, and encourage participation from bidders. Throughout the auction, the auctioneer ensures fairness, transparency, and proper conduct, creating a competitive and organized environment for all participants.



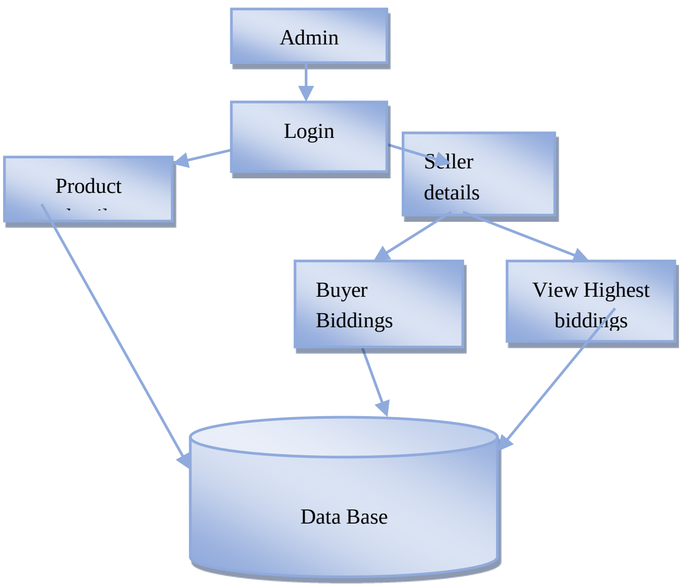
4. Buyer

In an auction, a buyer's goal is to purchase desired goods or services at a good value. They actively bid, aiming to outcompete others and secure the items they want for personal use, investment, or to resell, all while trying to avoid overpaying.



5. Admin

The admin module allows the admin to log in with a user ID and password. The admin manages and stores all data in the database, including tracking every user operation. This module provides access to both file details and user information.



VII. Related Work

A. Nonblockchain Decentralized Approaches

Nonblockchain auction systems, such as those using distributed agent architectures and hash tables, focus on verifiability and immutability but lack transaction ordering and time synchronization. A decentralized time synchronization method using a gossip protocol allows peers to synchronize time by sharing information until consensus is reached.

B. Centralized Approaches

Centralized auction platforms manage verifiability, immutability, ordering, and time synchronization through centralized control. Popular platforms like Tradera and eBay submit transactions to centralized databases. Other services enable B2B auctions, offering users interaction platforms and data allocation options.

VIII. REQUIREMENTS ENGINEERING

HARDWARE

PROCESSOR : PENTIUM IV 2.6 GHz, Intel Core 2 Duo.

RAM : 512 MB DD

MONITOR : 15” COLOR

HARD DISK : 40 GB

SOFTWARE

Front End :J2EE(JSP,SERVLET)

Back End : MY SQL 5.5

Operating System : Windows10

IDE : Eclipse

IX. DISCUSSION AND FUTURE DIRECTIONS

As discussed in Sections I and V, several approaches can be used to design open-cry auction systems, with centralized platforms being the most common. However, these platforms have drawbacks, such as a single point of control, potential bias, and lack of transparency. Non-blockchain systems address some of the key properties of auctioning systems, but blockchain offers a better solution due to its design characteristics. This paper highlights the limitations of blockchain, particularly in managing concurrent bids, and proposes a design to overcome these limitations.

Hyperledger Fabric was chosen for its modular architecture, which allows easy integration of functionalities like smart contracts. Other permissioned blockchains, like R3 Corda, also offer viable alternatives. This paper uses Hyperledger Fabric due to its anonymity and security features. The chaincode developed for the proof-of-concept (PoC) is optimized for efficient execution, but delays can arise from external service unavailability. The system’s performance is consistent with transaction latencies seen in other Hyperledger Fabric implementations. However, scalability challenges exist as more peers are added, leading to higher transaction times.

Hyperledger Fabric's ledger structure maintains verifiable and immutable transaction records. The ordering service ensures transactions are added sequentially, but its fairness may be affected by network factors. Additionally, the use of centralized APIs for NTP timestamps, while ensuring secure time synchronization, slightly deviates from blockchain's decentralized nature. This PoC approach serves as a foundation for future blockchain-based auction systems, with possible extensions to address concurrency and time synchronization issues.

X. CONCLUSION

This paper analyzed key properties for decentralized electronic auctions, highlighting essential design attributes and components required for a proof-of-concept. It identified how different systems address these properties but emphasized the need for additional features to fully meet them. A comprehensive qualitative and quantitative evaluation was conducted on both the blockchain system as a whole and the external time service, assessing their individual performance and effectiveness in the context of the proposed auction design.