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A Comprehensive Double Auction Mechanism for Edge Computing Services: A Survey

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Abstract – Edge computing is the way of performing certain computing task closer to where people and their devices are present. Getting certain resources at the same time is somewhat difficult. These papers present contemporary solutions to optimize useful resources in cell-side computing systems, offering various methods including on line auctions, decentralized auction-based fully incentive mechanisms, combiner multi public sales and double public sales schemes fair protest and ensure that the associated challenges should be made front writers those strategies To expand the eclipse, involve strategies such as algorithms, tactical contracts, and tools learning plays a role, eventually especially improved performance, higher individuals enjoy, and more accept the validity of the systems involved.

Keywords **- Edge computing, auction, bidding, service providers.**

I.INTRODUCTION

Edge computing is a manner to do some computing responsibilities closer to wherein human beings use their mobile gadgets. This enables lessen latency and enhance processing pace, mainly as related devices grow, and the demand for fast reaction places clusters of microcomputers on the Internet as they may try this, physically towards users than big traditional statistics facilities. These side servers can handle complicated obligations greater successfully, imparting a better experience for cellular users. Edge computing also addresses concerns related to bandwidth, power consumption, privacy, and security by providing a scalable and scalable solution for managing applications that require large amounts of modern data and computation bird. This collection of papers focuses on strategies for optimizing resource utilization in mobile gateway computers through various mechanisms such as online auctions, incentive strategies based on mass auctions and a combination of multiple purchasing dual strategies. These strategies leverage techniques such as rogue algorithms, intelligent contracts, and machine learning to create better asset management systems. The authors also present the Zero-Touch Network and Service Management (ZSM) framework as an emerging model for fifth generation (5G) and beyond networks to provide self-configuration and self-healing capabilities. In addition, the literature investigates the use of collaborative cooperation (CEC) to automate dynamic networks in terms of communication. Overall, these papers provide new ideas and frameworks for optimizing mobile edge computers and improving their overall performance.

II. LITERATURE SURVEY

In this section various authors have presented different auctions, bidding techniques and resource allocation using edge computing

In [1] a new strategy is proposed for protecting the privacy of transactions in the edge computing resource trading market. This approach includes the use of double auction system and applying differential privacy techniques based on Gaussian mechanisms. The goal is to improve the overall efficiency of the auction while ensuring the security and privacy of the auction market. Simulations have also shown promising results. These strategies also give positive and accurate results.

In [2] a new methodology has been developed to elevate the advantage of resources in edge computing, especially when using 5G/6G networks for the Internet of Things

(IoT). This strategy involves combining two types of auctions: one is focused on users and another one is focused on edge servers. The main aim is that everyone should be benefitted from this.

In [3] a new policy has been designed to improve the use of fog computing resources, which is an alternative to traditional cloud computing designed for mobile users and the Internet of Things (IoT). The proposed method, called Truthful Double Auction Task Offloading (TDAOGO), encourages fog providers to maximize their profits while completing tasks within specific timeframes and maintaining their reputation. This approach helps in maintaining the security, latency and tolerance, ensuring that everyone benefits from the system.

In [4] a new framework has made to help people buy and sell data responsibly. This system, known as the SOWM, includes a place where clients can trade data, rules about how trade should take place, and a specialized computer program that helps everyone get a fair deal. The aim is to ensure that everyone benefits from the data trading market while protecting their interests.

In [5] to meet the progressing demands of mobile applications and reduce their dependence on distant servers, edge computing has been introduced. It involves performing calculations closer to the end-users, resulting in faster processing times. One popular method of building edge computing applications is through the Function-as-a-Service (FaaS) model, which divides the workload among multiple edge servers. While this technique offers several advantages, it also presents certain issues, particularly related to function placement and reducing cold start delays. However, researchers are continuously working on to overcome from these challenges and enhance the FaaS model to fully exploit the potential of edge computing resources.

In [6] edge computing environments, where data is cached at various locations close to end-users, there is also a concern about the security and privacy risks that arises due to some unauthorized access or interception. Block chain technology has been proposed along with a positive solution to enhance the security and reliability of data caching in mobile edge computing systems. This paper suggests a decentralized data caching strategy using a greedy algorithm to reduce the transmission delay of requested content while considering constraints like storage space on each server and whether the content is already cached on the server

In [7] proposes a hierarchical auction-based resource allocation mechanism called Link Quality Matrix (LQM) auction, suitable for ad hoc networks in cloud robotic systems. They have introduced some algorithms which link to the quality indicator and aims to reduce global communication and unnecessary computation while maintaining fairness. Simulations demonstrate the effectiveness of the proposed LQM auction mechanism helps to improve the task execution and reduces the communication costs.

In [8] the Zero-Touch Network and Service Management (ZSM) framework has been implemented in order to manage the increasing complexity and data volume of modern 5G and beyond networks. It uses ML techniques to enable intelligent decision-making and reduces the need of humans. This paper provides a detailed examination of the applications of the ZSM framework, including network optimization, traffic monitoring, energy efficiency, and security aspects.

In [9] a new way has been developed to carry out several computing resources more efficiently in the Industrial Internet of Things (IIoT). It utilizes a decentralized auction process and smart contracts to make good connection with sensors and other intelligent devices. This technique includes some of the factors like device mobility, differences between edge servers, reliability, speed, and sensitivity.

In [10] researchers have developed certain strategies to make sure that clients using mobile devices and the Internet of Things (IoT) are charged fairly for the computing resources they use with respect to time. A common method used here is auctions, where people bid on how much they're willing to pay for these resources. However, sometimes people try to cheat the system by bidding very low but still get what they want. To address this issue, researchers have proposed an auction method that helps identify and prevent such bid-rigging behavior. They also suggest a way to calculate the optimal reserve price for a certain algorithm used in these types of auctions.

In [11] Researchers have proposed a way "auction" process, where servers decide whether or not to take on additional work based on how much they might get paid for it. This approach considers factors like the value of a task and how much effort it takes to complete it.

In [12] as the demand of cloud is increasing day by day due to increase in the resources in order to cope up with this, the researchers came up with some new technology called as “combined multi-auction double auction

method" (CDA-MAB). This strategy utilizes block chain technology in order to make it more secure and transparent.

In [13] the researchers have addressed some of the common challenges which include efficient & fair allocation of resources between client's personal devices, edge servers & multi-access edge computing (MEC).They decided to design the auction mechanism which include both computing and communication resources with high quality end-to-end services along with QoS. COMSA mechanism was proposed and applied to wireless networks by keeping some limits constraints among the sellers and buyers.COMSA uses double auction mechanism which uses 2 step processes for bidding mechanisms.

In [14] edge computing has several advantages such as low latency, fast data transmission and quick data delivery. When number of users demanding for same set of resources it leads to certain problems like security, energy management and privacy. The researchers address some of the problems faced by clients and ways to overcome from it. They proposed safe auction mechanism which covers certain aspects like resource allocation, computer downloads and network management.

In [15] the authors found a problem which synchronizes between the Mobile Edge Computing (MEC), service providers (SPs) and users (UEs) in different MECs, as the clients utilizes different environments, the resources will be limited. Auction Simulations are used to model the interactions and also aims to optimize the resource allocation, improves the overall QoS. The proposed solution will help to improve the performance of the MEC system by meeting resource constraints.

In [16], the researchers explored the challenges of how the allocation of resources has to be done according to the prices in MEC system. The objective is to improve the quality of the services. It proposed the sales-based approach to allocate the pricing of edge or cloud resources. The existing tools combine the various levels of combinatorial auctions and address the user requirements and heterogeneous resources across multiple system levels.

In [17] some of the challenges related to minimum latency of emerging applications such as IoT, Virtual reality/ augmented reality have been addressed. Researchers proposed some Edge and Fog computing solutions related to In-Network Computing Providers (INCPs) and Application Service Providers (It requires a distributed computing environment including AppSPs) and "Edge-MAP" is an auction-based resource allocation.

In [18] the trails associated with allocation of resources and Capitalization in a mobile edge computing (MEC) system, The users require something different from the same resource (like high quality/ security/privacy/latency/faster response etc). These requirements differ from user to user. Due to this issue "ERAP" (Edge Resource Allocation Problem) arises. In the beginning the author proposed this in the mathematical form as "MILP" (mixed-integer linear program) and then presented an optimal solution as NP-hard. After further research, they proposed two more solutions i,e auction mechanism and linear programming.

In [19], the scheme or idea related to heterogeneous capacity-limited edge node (ENs) for multiple competing networks in edge applications have addressed. The methodology combines 2 techniques: Eisenberg-Gale (EG) convex program and Vickrey-Clark-Groves (VCG) auction mechanism. By combining these two, they proposed a framework that achieves a "Balanced Solution" and maximizes resources, allocates quality resources, and ensures equity due to due to financial restrictions on services.

In [20], addresses the problem of mobile edge computing (MEC) related to resource allocation by keeping economic factors in mind. The concept of economies states that "the cost related to resources decreases when the production increases and vice-versa", which an extreme aspect in this paper. The main aim to create incentives for profit seeking firms to participate in the system as well as to improve the overall efficiency.

Table 1: Summarization of various Authors

Authors	Title	Research Focus	Remarks
Xutong Jiang et al.[1], 2021	Combinatorial double auction for resource allocation with differential privacy in edge computing	Techniques used such as online auctions, decentralized auction based incentive mechanisms, block chain Zero-Touch Network framework combinatory multi-auction & double auction schemes.	Difficult to implement due to complexity of technology. Proper Coordination should be established between the stakeholders.
Jianmao Xiao et al.[2], 2022	Multi-round auction-based resource allocation for edge computing: Maximizing social welfare	Improving the efficiency of resource usage in edge computing systems, particularly in the context of 5G/6G networks for IoT applications.	Implementation may require additional infrastructure and more investments.
Branka Mikavicaet al.[3], 2024	A truthful double auction framework for security-driven and deadline-aware task offloading in fog-cloud environment	The authors propose a novel truth discovery double auction (TDD) mechanism, which incentivizes fog providers to provide high-quality services while meeting specific deadlines.	Increased operational costs for service providers.
Jingyuan Duan et al.[4] ,2022	Optimal social welfare: A many-to-many data transaction mechanism based on double auctions	SOWM, which serves as a marketplace for buying and selling data, governed by a set of transparent and enforceable rules.	It requires significant coordination between data buyers and sellers to ensure smooth transactions.
Sahar Pilevar Moakhar et al.[5], 2024	An efficient mechanism for function scheduling and placement in function as a service edge environment	Addressing the challenges associated with the Function-as-a-Service (FaaS) model in edge computing environments.	It can be difficult to determine the optimal location for functions across different edge servers
Ge Wang et al.[6], 2022	Smart contract-based caching and data transaction optimization in mobile edge computing	Enhancing data security and reliability in mobile edge computing systems through the use of blockchain technology	Requires block chain network to ensure data consistency and security.
Lujia Wang et al.[7], 2017.	A Hierarchical Auction-Based Mechanism for Real-Time Resource Allocation in Cloud Robotic Systems	Hierarchical auction-based resource allocation mechanism called Link Quality Matrix (LQM) auction, suitable for ad hoc networks in cloud robotic systems.	disadvantage of this paper is that it primarily focuses on the resource allocation mechanism for multirobot systems in cloud computing environments

Mirna El Rajab et al.[8], 2024	Zero-touch networks: Towards next-generation network automation	The ultimate goal is to enhance the overall performance of 5G and beyond networks by leveraging the capabilities of the ZSM framework.	Significant coordination between network operators and ZSM developers to ensure seamless integration and operation of the framework.
Gaurav Baranwal et al.[9], 2022	BARA: A block chain-aided auction-based resource allocation in edge computing enabled industrial internet of things	Simulations show that this method can effectively address issues related to task offloading, bid-rigging behavior, and ensuring fairness in resource allocation.	Complex infrastructure
Hao Qiu et al.[10], 2021	Auction method to prevent bid-rigging strategies in mobile block chain edge computing resource allocation	IoT applications that consider factors like bid-rigging behavior and optimal reserve pricing. Detect and prevent bid-rigging while ensuring fairness in resource allocation.	It may require more complex algorithms and data structures to accurately model and predict bid-rigging behavior.
Xingqiu He et al.[11], 2022	An online auction-based incentive mechanism for soft-deadline tasks in Collaborative Edge Computing	Incentivizes edge servers to cooperatively handle tasks based on their respective capabilities and available resources.	It may be difficult to determine the optimal reserve price for specific tasks in a fair and transparent manner.
Xuyang Ma et al[12], 2021	Blockchain-enabled feedback-based combinatorial double auction for cloud markets	Network performance, promotes fair competition among service providers, and improves user experience.	It may be difficult to predict the price.
Xianhao Chen et al.[13] ,2022	End-to-End Service Auction: A General Double Auction Mechanism for Edge Computing Services",	MEC environments that consider factors like computation and communication resources, as well as (QoS) guarantees. COMSA mechanism	It may be difficult to determine the optimal reserve price for specific tasks in a fair and transparent manner.
Xuyang Ma et al[14] ,2021	Blockchain-enabled feedback-based combinatorial double auction for cloud markets	Enhance overall network performance while promoting trust and fairness in the system.	More complex algorithms and data structures to accurately model and predict task offloading behavior.
HELI ZHANG1 et al.[15] ,2017	Combinatorial Auction-Based Service Provider Selection in Mobile Edge Computing Networks,	Use of machine learning algorithms to optimize resource allocation while maintaining fairness in the system.	Result in higher computational costs and increased storage requirements for service providers.
Tayebeh Bahreini et al.[16] ,2019	An Envy-Free Auction Mechanism for Resource Allocation in Edge Computing Systems",	Efficient resource allocation framework for mobile edge computing environments that considers factors like computation and communication resources, as well as quality of service (QoS) guarantees.	Leading to inefficiencies in resource utilization.

G. Tasiopoulos et al.[17] ,2020	Edge-MAP: Auction Markets for Edge Resource Provisioning", Argyrios	Evaluating different pricing models for edge-cloud services and their impact on service providers' profitability and users' QoE.	Increased storage requirements for service providers
Tayebeh Bahreini et al.[18] ,2021	Mechanisms for Resource Allocation and Pricing in Mobile Edge Computing Systems,	It formulates the Edge Resource Allocation Problem (ERAP) as a Mixed-Integer Linear Program (MILP), proves its NP-hard complexity, and proposes two resource allocation mechanisms	Complex algorithms and data structures to accurately model and predict task offloading behavior, which could result in higher computational costs
Duong Tung Nguyen et al.[19], 2018	Price-based Resource Allocation for Edge Computing: A Market Equilibrium Approach	Allocating resources of heterogeneous capacity-limited edge nodes (ENs) to multiple competing services at the network edge in edge computing environments.	Scalability issues, cost and complexity.
Xiao Zheng et al.[20] ,2023	Resource allocation and network pricing based on double auction in mobile edge computing",	(DADPM) - for efficient resource allocation and matching between mobile devices and edge servers.	Implementing such a mechanism may require additional infrastructure investments and could potentially lead to increased operational costs for service providers.

III CONCLUSION

The auction mechanism has several advantages when used for resource allocation in systems like cloud computing, edge computing, or network infrastructures. Some key benefits include: Efficiency, Fairness, Market equilibrium, maximum social welfare, encourages competition and flexibity.

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