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Opinion Article

Enhancing Social Welfare through Multi-Round Auctions in Edge Computing Environments

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DESCRIPTION

Edge computing has emerged as a an important source for meeting the growing demands of latency sensitive applications in various domains. However, efficient resource allocation in edge environments remains a challenging task. This article proposes a multi-round auction based approach to allocate resources effectively, aiming to maximize social welfare in edge computing systems. Exploiting auctions, this method optimally matches resource providers with consumers, fostering an equitable and efficient allocation mechanism. Edge computing has gained prominence due to its ability to process data closer to the source, reducing the delay and enhancing performance for various applications, including Internet of Things (IoT), Augmented Reality (AR), and smart cities. However, resource allocation in edge environments presents significant challenges, including dynamic resource availability, heterogeneous computing capabilities, and diverse application requirements. Traditional centralized allocation mechanisms often struggle to address these complexities efficiently. In contrast, decentralized auction based approaches offer a promising solution by enabling autonomous resource allocation among self-interested entities.

Multi-round auction-based resource allocation

The available multi round auction based resource allocation scheme aims to maximize social welfare by efficiently matching resource providers with consumers in edge computing environments. The allocation process unfolds over multiple rounds, allowing participants to iteratively bid for and allocate resources based on evolving demands and availability.

Bid submission: Participants, including edge devices, service providers, and resource brokers, submit their bids specifying resource requirements, preferences, and valuation. Bids may include computational resources, storage capacity, bandwidth, and other relevant attributes. Each participant optimizes its strategy to maximize its utility, considering factors such as cost, Quality of Service (QoS), and application requirements.

Auction mechanism: Auctioneer (central coordinator or decentralized protocol) aggregates bids and conducts auctions to allocate resources efficiently. Various auction formats, such as sealed-bid auctions, ascending auctions, or combinatorial auctions, can be employed based on the characteristics of the resource allocation problem. Auction mechanisms consider both the bid prices and non-price attributes (e.g., QoS guarantees) to determine the allocation.

Resource allocation: Upon auction completion, resources are allocated to winning bids based on auction outcomes. Allocated resources are provisioned to the corresponding participants, ensuring adherence to bid specifications and service level agreements (SLAs). Participants that win resources adjust their subsequent bids based on the allocated resources and updated market conditions for future rounds.

Benefits of multi-round auction-based approach

Efficiency: The multi-round approach allows for iterative refinement of resource allocation, enabling participants to adjust their strategies based on evolving market dynamics.

Fairness: By incorporating diverse preferences and valuation metrics, the auction mechanism promotes fairness and equitable resource distribution among participants.

Adaptability: The decentralized nature of auctions enables scalability and adaptability to dynamic edge environments, accommodating fluctuating demands and resource availability.

Social welfare maximization: By optimizing resource allocation based on social welfare objectives, the proposed approach enhances overall system efficiency and utility, benefiting all stakeholders.

Consider a smart city deployment where edge computing resources are utilized for various applications, including traffic management, environmental monitoring, and public safety. The multi-round auction-based resource allocation approach can effectively allocate computational resources, sensor data streams, and communication bandwidth to different stakeholders, optimizing

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system performance and societal benefits. In the exponentially landscape of edge computing, efficient resource allocation is crucial for maximizing social welfare and ensuring equitable access to resources. The multi-round auction-based approach presented in this article offers a promising solution by enabling dynamic and decentralized resource allocation mechanisms. By iteratively matching resource providers with consumers based on evolving demands and preferences, this approach fosters efficiency, fairness, and social welfare maximization in edge computing environments.