Collusion in Cloud Computing Auctions

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CCS CONCEPTS

• **Theory of computation → Computational pricing and auctions**; *Algorithmic mechanism design*; • **Computing methodologies → Multi-agent systems**; • **Computer systems organization → Cloud computing**;

KEYWORDS

Cloud, Auctions, Collusion

Cloud computing provides flexibility to clients by allowing them to pay per use for the rental of services and VMs. Renting reduces the waste of prepurchased but unutilized hardware. Recently, cloud computing has been moving towards the more economical Resource-as-a-Service model (RaaS) [2]: instead of horizontal scaling (purchasing more VMs), RaaS clouds enable vertical scaling—purchasing more resources (e.g., CPU, RAM, and I/O resources) for a few seconds at a time, at sub-second granularity. For example, CloudSigma charges separately for resources and adjusts prices every few minutes. Amazon Web Services (AWS), Azure and Google Cloud Platform all offer pay-as-you-go pricing. AWS Lambda and Azure Functions allow uploading code and paying for computing time only when the code is triggered to run.

RaaS systems use economic mechanisms, such as auctions, to allocate resources [3, 4]. AWS EC2 [1], Alibaba Cloud and Packet spot instances are examples of auctions in horizontal elasticity. Vickrey-Clarke-Groves (VCG) auctions, as used by Facebook to allocate ad spaces, are likely to be used in the near future for vertical elasticity. Ginseng systems are examples of VCG auctions used for RAM [3] or cache [4] allocation. In Ginseng [3], guests run economic agents who bid for resources auctioned by the host. Thus, the mechanism incentivizes selfish, rational agents, who only care about their own profit, to bid with their true valuation of the RAM.

These economic mechanisms efficiently allocate resources to the users who value them most, thus maximizing the social welfare (SW): the aggregate valuation of all users from the resource allocated to them. However, they incur additional costs to the users, possibly hindering profitability. VCG auctions are also not collusion-proof. Colluding to increase profit may reduce SW, e.g., by bid rotation or sub-optimal redistribution of the goods.

Our method enables guests to form coalitions that increase their profits. It does not change the auction efficiency, and thus does not harm the SW. In this model, guests can ask the host to compute their bill as if they were a single guest. Since VCG is based on exclusion-compensation, where guests pay for the damage they cause others, they would pay less if they are billed together. The guests trust the host, with whom they share their valuations in the auction, but mistrust each other. They tell the host how they want to share the discount. The host calculates the reduced bills accordingly. RaaS hosts have an incentive to support coalitions, to discourage guests from colluding in a harmful manner.

Experiments show that our mechanism increases participants' mean profit by up to 40%, without harming the provider's allocation efficiency. Additionally, in a mixed environment, profit will be maximized for an agent willing to accept a profit share of at least 30% and who offers partners 40%. We also found that large coalitions do not necessarily benefit their members.

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