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Analysis of Economic Models for Cloud Computing Resource Management

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Abstract - In cloud settings, it is a hard task to manage resources, design applications, and create use models. This is because several organizations hold resources that are spread out across multiple locations. Owners of various resources have diverse regulations about their use or access, as well as varied payment structures, loads, and availability. There are a plethora of economic models that attempt to allocate resources and control supply and demand in cloud computing settings in an effort to tackle difficult resource management problems. Several cloud computing economic models have been compared in this research.

Keywords - *Economic, Pricing, Marketplace*

I INTRODUCTION

A new paradigm for handling massive challenges in the scientific, technical, medical, and commercial spheres has been introduced by cloud computing. These days, this software lets you form VEs, or virtual enterprises, where you share resources with other businesses. Applications (commercial, scientific, and engineering) with varying demands (CPU, I/O, memory, and/or network intensive), fabric management systems (such as queuing systems and supercomputers), and heterogeneous resources (such as workstations, clusters, and supercomputers) make up the system. Users, producers (also referred to as resource owners), and consumers all have distinct aims, plans, and demand dynamics. When it comes to human economies, decentralization and heterogeneity are inevitable. The economic approach provides a reasonable foundation for handling these issues. Several cloud computing economic models are compared in this research. Algorithms, regulations, and instruments for resource sharing and allocation in Grid systems are provided by competitive economic models.

II PLAYERS IN CLOUD MARKET

The idea of offering information technology assets as utilities is brought about by cloud computing. Cloud computing, as a whole, is distinct from cloud computing with an eye toward the market. A market is a venue where transactions may take place. A market is a meeting place for buyers and sellers to exchange products and services. Any place where buyers and sellers interact, whether in person or online, is considered a market. Cloud service providers and cloud service consumers/brokers are the two primary actors in the cloud computing ecosystem. When users and cloud service providers swap resources, they employ a variety of interaction protocols or economic models for determining the cost of service access. Now, if we think of IT assets and services as utilities, it's easy to see how the service provider and customer engage in a trade-off. This allows the user to utilize the service according to the SLA that was given.The user typically chooses a single cloud computing provider from a pool of available options and uses that provider's services for as long as they're needed.

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In the economic cloud model, the community of users stands for demand, much as in the traditional marketplace, while the community of resource owners (CSPs) stands for supply. We highlight the user community and their ability to affect resource price via brokers in the economic model. When resources are only utilized and not purchased by consumers, as they are for real-world services, prices become a significant aspect in the model, but they are just one of many. Consumers and service providers (CSPs) engage in resource exchange and service access in a market setting that is competitive.

Various criteria used for judging effectiveness of a market model are [1]:

• Social welfare (global good of all)
• Pareto efficiency (global perspective)
•Individual rationality (better off by participating in negotiation)
• Stability (mechanisms that cannot be manipulated, i.e., behave in the desired manner)
• Computational efficiency (protocols should not consume too much computation time)
•Distribution and communication efficiency(communication overhead to capture a desirable global solution).

III CLOUD COMPUTING STRATEGIC CONSIDERATIONS AND COSTS

The IT context of your organization and its strategic direction need to be taken into account when deciding how any cloud costing model is applied. There are two important points worth paying attention to here:

A Data center capacity: Data center space is becoming more scarce for many enterprises. Extra space will probably be quite expensive if they do run out. Therefore, clearing up space in the data center might result in capacity that is more valuable than it first seems for certain firms (as it will delay or even eliminate the need for additionaldata center space).

B Application grouping: Because of the advent and widespread adoption of service oriented architecture, the interdependence of application services has increased. For technical integration and performance reasons, it may be impractical to think of applications on an individual basis, and instead to group them together when considering cloud migration.

IV ECONOMIC MODELS

A Commodity Market (Flat or Supply-and- Demand Driven Pricing) Model

The commodities market model states that resource owners set their service prices and consumers charge based on the quantity of resource used.Depending on the availability and demand for the resource, the pricing strategy might be either flat or variable, determined from a number of characteristics. Prices for services are often set to keep the market in a state of balance between supply and demand. In the flat price model, the fee stays the same for a particular amount of time regardless of how good the service is. In contrast to the frequent price fluctuations seen in models based on changes in supply and demand, this one is unaffected by demand. In theory, prices are raised until there is a balance between supply and demand, which happens when either demand or supply goes up or down.

Pricing Schemes in a Commodity Market Model can be based on:
• Flat fee
• Usage Duration (Time)
• Subscription
• Demand and Supply-based [2]
A simple price specification may contain thefollowing parameters.
{
. . .
consumer_id // Consumer-ID
peak_time_price // 9am-6pm: office hours onworking days
lunch_time_pirce // (12.30-2pm) offpeak_time_price // (6pm-9am), discount_when_lightly_loaded // if_load is less than 50% at any time
raise_price_high_demand // % raise price ifaverage load is above 50%
price_holiday_time // during holidays and weekends!
. . .
}
Consumers can be charged for access to various resources (CPU cycles, storage, software, and network). The resource broker (working for the user) can carry out the following steps for executing applications:

a. The broker identifies resource providers It identifies suitable resources and establishes their prices
b. It selects resources that meet objectives (lower cost and meet deadline requirements). It uses heuristic techniques

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while selecting resources and mapping jobs to resources.
c. It uses them and pays them as agreed.

B Posted Price Models

The posted price model is similar to the commoditymarket model, except that it advertises special offers in order to attract (new) consumers to establish market share or motivate users to considerusing cheaper slots. In this case, brokers need not negotiate directly with CSPs for price, but use posted prices as they are generally cheaper compared to regular prices. The posted-price offers will have usage conditions, but they might be attractive for some users. For example, during holiday periods, demand for resources is likely to be limited and CSPs can post tempting offers or prices aiming to attract users to increase resource utilization. The activities that are specifically related to the posted-price model in addition to those related to commodity market model are:

a. Resource/Cloud Service Providers (CSPs) posts their service offers and conditions etc. in CloudMarket Directory.
b.Broker looks at Cloud Market Directory to identify if any of these posted services are availableand fits its requirements
c. Broker enquires (CSP) for availability of posted services.
d.Other steps are similar to those pointed out in commodity market model.

C Bargaining Model

Prior models relied on access charges set by CSPs and paid for by brokers. Under this strategy, resource brokers negotiate with CSPs to increase the length of use and decrease the price of access. As long as their respective goals are satisfied, brokers and CSPs will bargain with one another. In the beginning, the brokers may charge a cheap price while CSPs charge a higher price. They keep negotiating until they find a price that works for both of them, or until one of them gives up. Brokers may take risks, bargain for reduced costs, and even abandon pricey devices if customer needs (such as a loosened deadline) lead the transaction. Because of this, resource usage could drop, and CSPs would be ready to slash prices to prevent resource cycles from going to waste. When service pricing and market supply and demand are unclear, brokers and CSPs often use this approach. Users have the option to bargain for a discounted rate by offering a future favor or continued usage of CSP services.

D Tendering/Contract-Net Model

Tender/Contract-Net model is one of the most widely used models for service negotiation in adistributed problem solving environment [6]. It is modeled on the contracting mechanism used by businesses to govern the exchange of goods and services. It helps in finding an appropriate service provider to work on a given task. To meetobjectives brokers and CSPs interact with each other in their bid. A user/resource broker who is asked to solve the task is called the manager and resource that might be able to solve the task iscalled potential contractor. From a manager's perspective, the process is:

1. Consumer (Broker) announces its requirements (using deal template) and invites bids from CSPs.
2. Interested CSPs evaluate the announcement andrespond by submitting their bids
3. Broker evaluates and awards the contract to themost appropriate CSP(s)
4. The broker and CSP communicate privately anduse the resource (R)

The contents of the deal template used for work announcement include, addressee (user), eligibility requirements specifications (for instance, Linux, x86arch, and 128MB memory), task/serviceabstraction, optional price that the user is willing toinvest, bid specification (what should offer contain), expiration time (deadline for receiving bids).

From a contractor's/CSP perspective, the processis:

1. Receive tender announcements/advertisements
2. Evaluate service capability
3. Respond with bid
4. Deliver service if bid is accepted

E Auction Model

The auction model supports one-to-many negotiation, between a service provider (seller) and many consumers (buyers), and reduces negotiation to a single value (i.e., price). The auctioneer setsthe rules of auction, acceptable for the consumers and the providers. Auctions basically use market forces to negotiate a clearing price for the service. In the real world, auctions are used extensively, particularly for selling goods/items within a set duration. The three key players involved in auctions are: resource owners, auctioneers (mediators), and buyers. Many ecommerce portals such as Amazon.com and eBay.com are serving as mediators (auctioneers). Both buyer's and seller's roles can also be automated. In a Cloud environment, providers can use an auction protocol for deciding service value/price. The steps involvedin the auction process are:

a. CSPs announce their services and invite bids.
b. Brokers offer their bids (and they can see what other consumers offer if they like - depending on open/closed).
c. Step (b) goes on until no one is willing to bid higher price or auctioneer may stop if minimum price line is not reached or owner's any other specific requirements are not meet.
d. CSP offers service to the one who wins
e. Consumer uses the resource

Auctions can be conducted as open or closed depending on whether they allow back-and-forth offers and counter offers. The consumer may update the bid and the provider may update the offered sale price. Depending on these parameters, auctions can be classified into four types [1]:

- English Auction (first-price open cry)
- First-price sealed-bid auction

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- Vickrey (Second-price sealed-bid) auction [7]
- Dutch Auction

• In an English auction, known as a "first-price open cry," any bidder is allowed to raise their price until it surpasses all others. The auction concludes when no one is prepared to pay more for the object, and whomever bids the most gets it. Each bidder in a first-price sealed-bid auction makes a single bid without being aware of the other bidders' positions. The item is awarded to the bidder who has placed the highest price. Here, the private value and the past perceptions about other bidders' values determine the broker's offer approach. The optimal tactic is to submit a lower price than the item's actual worth; whether or not this results in a winning bid is contingent upon the other bids. Each bidder in a Vickrey (Second-price sealed-bid) auction makes a single bid without being aware of what the other bids are. At the second-to-last-bid price, the item is won by the highest bidder [7].

In a Dutch auction, the auctioneer sets a high initial bid or price and gradually reduces it until an item is sold at the current price. In both this and the first-price sealed-bid auction, the only thing that counts is the highest offer, and no important information is disclosed during the auction.

F Bid-based Proportional Resource Sharing Model

In cooperative problem-solving settings, such as clusters (in a single administrative area), proportionate resource sharing systems based on the market are particularly common. Here, the user's bid relative to other users' bids determines what part of the available resources are allotted to their application. Tokens or credits are given to users so they may access resources. The demand for the resource and the value that other users assign to it when it is used determine the value of each credit.

V. ECONOMIC MODELS COMPARISION

Economic Model	Pricing Approach	Pros	Implementation
Commodity Market Model	flat or variable depending on the resource supply and demand	Consumers can be charged according to the usage of resources	Mungi[8], Enhanced MOSIX[9], and Nimrod/G [3][4]
Posted Price Models	Posted price which offers usage conditions	It provides special offers, motivate users and provide cheaper slots	Nimrod/G[3][4]
Bargaining Model	Price is based on negotation	Provides facility of bargaining for lower access price and higher usage duration.	Mariposa[10] and Nimrod/G
Tendering/Contract-Net Model	Bidding	Widely used for contracting mechanisms	Mariposa [10]
Auction Model	use an auction protocol for deciding service value/price	Based on auctions	Spawn [11] and Popcorn [12]
Bid-based Proportional Resource Sharing Model	Bidding	Commonly used in cluster environments	Rexec/Anemone [13]

VI CONCLUSION

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V We have compared many economic models in this research.Our research has shown that many models have varying price structures, allowing users to choose the perfect fit for their needs and budgets.In addition, certain users have access to different models' benefits and features at different times.Therefore, the user's need, budget, and time limitation determine which model is best.

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