Comparision on Economic Models for Resource Management in Cloud Computing

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Abstract *- Resource management, application development and usage models in cloud environments is a complex job. This is due to the geographic distribution of resources that are owned by different organizations. The resource owners of each of these resources have different usage or access policies and cost models, and varying loads and availability. In order to address complex resource management issues, there are numerous economic models for resource allocation and to regulate supply and demand in cloud computing environments. In this paper we have given the comparison of some economic models in cloud computing.*

Keywords *- Economic, Pricing, Marketplace*

I INTRODUCTION

Cloud computing has emerged as a new paradigm for solving large-scale problems in science, engineering, medical and commerce. In these days, this technology enables the creation of Virtual Enterprises (VE) for sharing of resources. It consists of heterogeneous resources (PCs, Work statations, clusters, and supercomputers), fabric management systems (single system image OS, queuing systems, etc.) and policies, and applications (scientific, engineering, and commercial) with varied requirements (CPU,I/O, memory, and/or network intensive). The users, producers also called resource owners and consumers have different goals, objectives, strategies, and demand patterns. The economic approach provided a fair basis in successfully managing decentralization and heterogeneity that is present in human economies. In this paper we compare various economic models for cloud computing. Competitive economic models provide algorithms/policies and tools for resource sharing/allocation in Grid systems.

II PLAYERS IN CLOUD MARKET

Cloud computing introduces the concept of providing IT assets as utilities. The term cloud computing is different from term market oriented cloud computing. Market refers to a place to conduct trade. It refers to gathering of people to conduct sales and purchase of goods. Market is operation of trading either in the physical or virtual environment. There are mainly two key players in cloud computing: Cloud service provider and cloud service consumer/broker. When cloud providers and consumers trade their resources, they use various economic models or interaction protocols for deciding service access pricing. Now if we consider IT assets and services as utilities, it is clear that there is trade-off between service provider and consumer, this enables the use of service by the user under provided SLA.User generally selects one cloud computing vendor from among a group of competing providers and leverage its services as long as they need them.

As in the conventional marketplace, the users' community represents the demand, whereas the resource owners' community (CSPs) represents the supply in economic cloud model. In the economic model, we put emphasis on the user community and how they can influence the pricing of resources via their brokers. Prices are only one factor in the model but play an important role when resources are only used and not bought by the users, as for real world services. The service providers (CSPs) and consumers interact in a competitive market environment for resource trading and service access.

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: Many organizations are running out of data center space. If they do run out of space, there's likely to be a massive cost in getting extra space. Thus, for some organizations, freeing up space in the data center creates capacity that's more valuable than it might otherwise appear (because it will

delay or even eliminate the need for additional data 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

In the commodity market model, users charge according to the amount of resource they consume and resource owners specify their service price .The pricing policy can be derived from various parameters and can be flat or variable depending on the resource supply and demand. In general, services are priced in such a way that supply and demand equilibrium is maintained. In the flat price model, once pricing is fixed for a certain period, it remains the same irrespective of service quality. It is not significantly influenced by the demand, whereas in a supply and demand model prices change very often based on supply and demand changes. In principle, when the demand increases or supply decreases, prices are increased until there exists equilibrium between supply and demand.

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 the following parameters.

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. . .
consumer_id // Consumer-ID
peak_time_price // 9am-6pm: office hours on working 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 if average 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
b.It identifies suitable resources and establishes their prices
c. It selects resources that meet objectives (lower cost and meet deadline requirements). It uses heuristic techniques while selecting resources and mapping jobs to resources.
d. It uses them and pays them as agreed.

B Posted Price Models

The posted price model is similar to the commodity market model, except that it advertises special offers in order to attract (new) consumers to establish market share or motivate users to consider using 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 Cloud Market Directory.
b.Broker looks at Cloud Market Directory to identify if any of these posted services are available and 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

In the previous models, the brokers pay access prices, which are fixed by CSPs. In the bargaining model, resource brokers bargain with CSPs for lower access price and higher usage duration. Both brokers and CSPs have their own objective functions and they negotiate with each other as long as their objectives are met. The brokers might start with a very low price and CSPs with a higher price. They both negotiate until they reach a mutually agreeable price or one of them is not willing to negotiate any further. This negotiation is guided by user requirements (e.g., deadline is too relaxed) and brokers can take risk and negotiate for cheaper prices as much as possible and can discard expensive machines. This might lead to lower utilization of resources, so CSPs might be willing to reduce the price instead of wasting resource cycles. Brokers and CSPs generally employ this model when market supply-and-demand and service prices are not clearly established. The users can negotiate for a lower price with promise of some kind favour or using CSPs services even in the future.

D Tendering/Contract-Net Model

Tender/Contract-Net model is one of the most widely used models for service negotiation in a distributed 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 meet objectives 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 is called 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 and respond by submitting their bids
3. Broker evaluates and awards the contract to the most appropriate CSP(s)
4. The broker and CSP communicate privately and use 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/service abstraction, optional price that the user is willing to invest, bid specification (what should offer contain), expiration time (deadline for receiving bids).

From a contractor's/CSP perspective, the process is:

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 sets the 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 involved in 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
- Vickrey (Second-price sealed-bid) auction [7]
- Dutch Auction

English Auction (first-price open cry) –all bidders are free to increase their bids exceeding others offers. When none of the bidders are willing to raise the price anymore, the auction ends, and the highest bidder wins the item at the price of his bid.

First-price sealed-bid auction –each bidder submits one bid without knowing the other's bids. The highest bidder wins the item at the price of his bid. In this case a broker bid strategy is a function of the private value and the prior beliefs of other bidder's valuations. The best strategy is bid less than its true valuation and it might still win the bid, but it all depends on what the others bid.

Vickrey (Second-price sealed-bid) auction—each bidder submits one bid without knowing the other's bids. The highest bidder wins the item at the price of the second highest bidder [7].

Dutch Auction –the auctioneer starts with a high bid/price and continuously lowers the price until one of the bidders takes the item at the current price. It is similar to first-price sealed-bid auction because in both cases bid matters only if it is the highest, and no relevant information is revealed during the auction process.

F Bid-based Proportional Resource Sharing Model

Market-based proportional resource sharing systems are quite popular in cooperative problem-solving environments like clusters (in single administrative domain). In this model, the percentage of resource share allocated to the user application is proportional to the bid value in comparison to other users'bids. The users are allocated credits or tokens, which they can use for having access to resources. The value of each credit depends on the resource demand and the value that other users place on the resource at the time of usage.

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

In this paper we have compared different economic models.We have concluded that every model has different pricing approach which can help the user to select a particular model according to his requirement and budget.Also every model provides its own advantages and facilities for different users at different time slots.So selection of particular model depends upon the user's requirement and budget and time constraint.

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