

A Framework of Multi Agent System in Cloud Computing

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Abstract— As the cloud computing is becoming attractive for business owners as well as the resource users and the most frequently used technology, the researchers have realized the need of automated system to explore the power and to improve the performance and functionality of cloud computing. In this paper, we discuss the architecture of one such system consisting of Multi-agent System (MAS) which primarily focuses on the price negotiation mechanism between cloud users and providers and is being designed to ease the difficulties of both cloud users and cloud providers and to harness the full potential of cloud computing. The model is based on cooperative and collaborative agents and is managed centrally.

Index Terms— Cloud Computing, Multi Agent System, Negotiation, Automated System.

I. INTRODUCTION

With the success of Internet in the past few decades, the style of computing has been changed. Computing resources are shifted to remote places instead of personal computers. These resources are available as a service on Internet [2]. This type of computing has been considered as a 5th utility after electricity, water, telephone and gas with “pay-as-you-go” model [1]. Although, there are number of computing paradigm available to deliver this idea, we will consider the latest one, known as “Cloud Computing”. It has emerged as an opportunity for IT users to use IT resources with a reduced cost and increased efficiency. With the increase of cloud providers and therefore the cloud services, it might be a challenge for the cloud user to harness the benefit of this computing style. There are certain search engines available that are providing assistance to the cloud user in searching the relevantly best service with optimized features among many different types of services and negotiating for SLA (Service Level Agreement) [17], however there is no support for price negotiation. The actors involved in cloud computing transactions are typically humans who browse through the provider’s website and make purchase (fixed price), if suitable. This issue is due to the lack of mechanism of providing negotiation interfaces by

current providers to handle it dynamically. Instead, the service discovery is based on the best fit price provided by the cloud provider. So, the sophistication and degree of automation is required to be increased for both cloud users and providers to make the computing paradigm more personalized and dynamic. To attain this degree of automation and to take up cloud computing style to second generation level a new model is required. Whereas, the initial concept has been introduced in [3], this paper is intended to present a model called Cloud Computing Marketplace (CCM) to implement such platform with the help of agent based technology which is vendor independent and platform neutral. Cloud user is required to specify the requirements as input parameter. These requirements are based on the 1) type of service, 2) key word, i.e. some common terminology, associated with the service, 3) the range of price suitable to the user and 4) the time duration. To the specifications, the model will not only display the list of cloud services associated with the key word fulfilling the requirements but also offer negotiation facility to overcome limitations in similar kind of search engines.

The system is implemented with the help of agent base technology which provides a high level software abstraction which makes it a most promising area to inter-operate with other heterogeneous systems. We present the model implementation of our architecture using JADE (Java Agent DEvelopment) [4] framework.

II. RELATED WORK

The increasing demand of cloud services by cloud user has generated the need to automate this style of computing [5] and dynamically satisfy the complex requirement of cloud users as and when they emerge. These requirements generate the new challenges in cloud computing field such as service discovery, service composition etc. When talked about such an automated system, need for an agent paradigm has been emphasized [6,7,8,9]. The need of such an automated system has already been discovered in [10] and has defined such a system as agent based cloud computing.

A dynamic composition of loosely coupled web services has been studied widely with respect to semantic aspects [12, 13], service interaction, failures handling and validating and verifying service compositions [14]. Initial efforts have been put in [19,20] to tackle the cloud service composition. A web Service Matching Algorithm (SMA) between cloud computing services has been presented in [19] with multiple input/ output parameters based on semantic similarity. In [20], a framework has been proposed for performing cloud

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service composition in a multi-cloud environment. It presents methods to select a cloud combination which are feasible and contain minimum clouds.

A Broker-Based Agent Community Protocol (BBACP) has been implemented for e-business communities which include

the channel of joining e-business in the community, knowledge discovery and exchange and advertising services or capabilities with a hierarchical brokering architecture [15]. In [11] an agent based search engine: cloudle id designed which consists of service discovery and service composition and support three types of reasoning: similarity reasoning, compatibility reasoning and numerical reasoning.

Negotiation is a process of settling down the differences or reaching to an agreement by compromising so as to avoid any argument or dispute. It is an integral part for nearly all people especially when it comes to business organization. The most common form of business negotiation is buyer-seller negotiation. A lot of researchers have devoted to multi-agent based negotiation [16] research due to the rapid development of Artificial Intelligence, Automated-Oriented Computing and Multi-Agent System. Negotiation involves one agent trying to contract some other agents who can provide the best bid. In fact, contracts are the building blocks of business relationships between organizations. The contract operation involves the establishment of negotiation terms of the contract between the parties and monitoring and enforcing the contract for performance. The Contract Net Protocol (CNP) is a fully automated high level protocol for buying and selling goods in electronic market place. CNP is used in contract based coordination to handle task allocation issues. Task allocation is a problem where responsibility and resources have to be assigned to the agents. The first Multiagent contracting protocol was originally proposed by [18]. In this protocol an agent acts as an initiator or participant or both. An initiator sends out a Call for Proposal (CFP) to each participant to review CFP and then bids on feasible ones. The initiator then considers the best bid from participants and rewards a contract to that participant rejecting the bids from other participants. Sandholm [23] extended this protocol for the formalization of the bid and award decision process based on marginal cost calculations which were untouched in the original work along with task clustering to handle with the situation of large number of announcement and bid messages. The protocol was verified using TRACONET (TRANSPORTATION COOPERATION NET).

Service Level Agreement (SLA) negotiation has been established [21] to resolve the conflict of participants over different preferences of cloud services. In cloud market place, negotiation would help in achieving performance and hence business goals with the usage of resource level information. Consequently, a negotiation model is defined which is based on optimization of non-additive utility function [22].

III. AGENT BASED NEGOTIATION FRAMEWORK IN CLOUD COMPUTING

Cloud Computing is a powerful technique and is based on multiple resources. It is often compared with virtualization where physical infrastructure is separated to create various

dedicated resources. In Cloud Computing the resources are stored at remote location and accessed through Internet. In order to obtain a solution for price negotiation between cloud user and provider in the current cloud context, an architectural model is perceived to address the issue. Two independent components are required interacting under a well defined protocol:

A cloud interface implementing the negotiation model allowing the cloud users to specify the requirements and Cloud providers that accept the request and provides the best proposal for the request.

The work flow of the automated negotiation for the cloud computing model is shown as in fig 1.

Although, there exists many concepts of negotiation, but the framework of negotiation we are considering here is of Jennings et al. [28] who categorizes the negotiation in three broad elements: Negotiation Protocol that defines the set of rules that govern the negotiation, Negotiation objects represents the issues over which the participants negotiate and reach to an agreement and Agent's decision making models i.e. the decision mechanism deployed to achieve the objectives in line with the negotiation protocol. Agents are the negotiators in agent based negotiation system.

The providers have to get themselves registered before they can participate in the cloud market place. Once a provider is registered with the marketplace it can be displayed to the cloud user for the requirement. When user submits its requirements by specifying the type of service, key word based on the type of service, the range of affordable price and the limit of time duration, the CCM will display the list of all the providers matching the specified requirements. The cloud user can choose any one of provider or all the providers from the list to start the negotiation with. The negotiation process is mainly based on the range of price and the range of time duration specified by the cloud user. The cloud providers and cloud buyer will both evaluate the present price based on their price limits respectively for the negotiation process using a utility function U . The cloud providers will send their calculated present price to the cloud buyer for its recommendation. The cloud buyer compares the price with its calculated present price and if meets the requirement, send the acceptance to the provider. If it does not meet the requirement, a refusal is sent for a bid of new price to the providers. Negotiation process continues till either both (providers and buyers) reach to some agreement or the time limit set for the process expires. To implement the process we use multi-agents as participants playing the role of cloud providers and cloud buyers to negotiate with each others. These agents act as mediators between cloud buyers and cloud providers.

The concept of employing agents to perform computer based task was originated by Nicholas Negroponte [26] and Alan Kay [25]. However, Pattie Maes [27] has discussed two solution: *competence* i.e. to score the knowledge to decide major problems that are involved in building an agent based when, what and how to help the user and *trust* to guarantee the user to achieve the goal comfortably by delegating tasks to an agent.

IV. ARCHITECTURE OF THE SYSTEM

The system is a multi-agent system that will interact with the CCM on behalf of cloud user in order to get the list of all cloud providers that satisfies the user’s requirement. The system has been designed and developed using JADE which is a FIFA (The Foundation for Intelligent Physical Agents) [24] compliant. The architecture of the system is dynamic and is given in fig 2 that has mainly two layers: application layer and Internet layer.

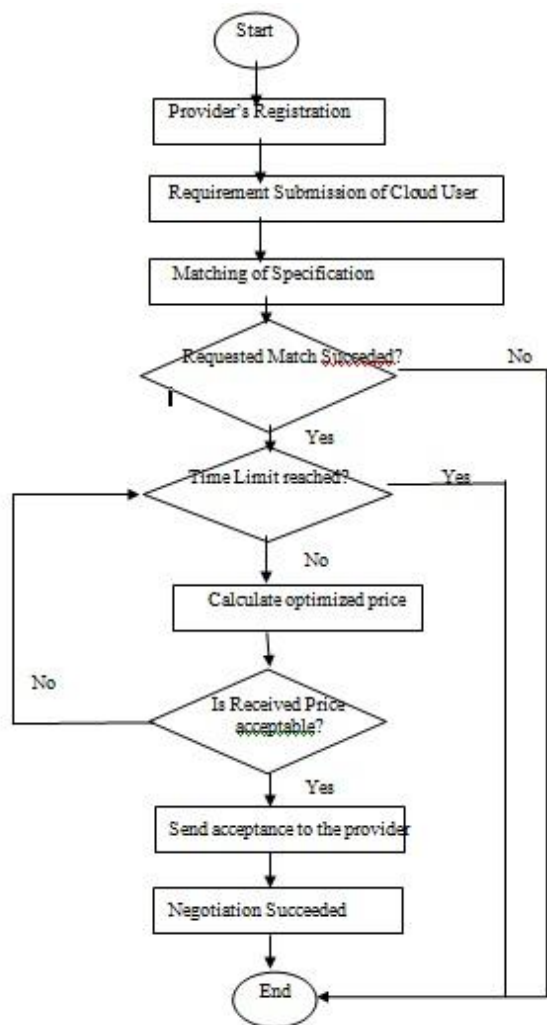


Fig.1 Workflow of the model

• Application Layer:

This layer consists of only one component known as standard interface. This layer allows the client to send query to the CCM. The objective of this layer is to get the requirement from the cloud user to meet his needs to the best. The standard interface is responsible for the interaction with the user to achieve specific task. The result is then sent to the second layer, Internet layer.

• Internet Layer:

This layer acts as a server and contains all the components required to execute the process. This layer is skilled with the ability to accept the request, process and return the result back to the application layer. It contains the database that manages all the information of the registered cloud providers. The other components of this layer are

1. Agent Generation Service Manager which is responsible for generating the necessary agents for cloud buyer and cloud providers responsible for the negotiation process,
2. Agent Management Service responsible for managing all the agents generated in agent generation service, retrieval of data which is responsible for searching the database for the matching needs of the cloud user received from the application layer,
3. Optimization and Decision Service Manager which performs the negotiation mechanism in order to achieve the task as specified by the cloud user.

V. INTERACTION OF CLOUD BUYERS AND CLOUD PROVIDERS

The connection process of buyers and sellers in this model is based on a set of predefine selection criteria in a specific domain. This connection is carried out in the following stages:

1. Obtaining the request from buyer, comparing the request with the information of registered providers and selecting the most appropriate profiles and preferences that are matched very closely. This requires a focus decision [18] to connect the two parties.
2. The next stage is to filter out the selection obtained in first stage i.e. choosing the number of providers with which request for negotiation is to be sent. The importance of this process is to ensure that cloud buyer gets the most desirable results.

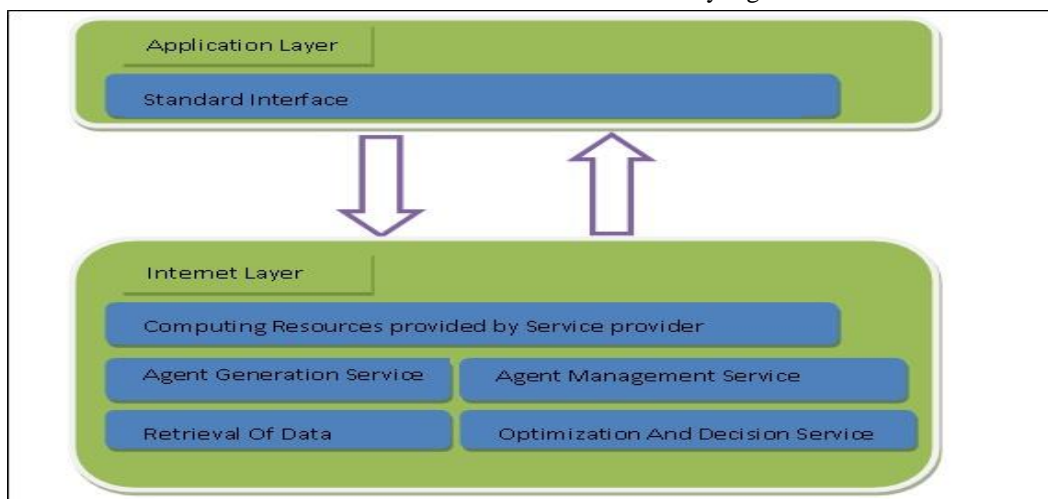


Fig. 2 Architecture of the model

3. The last stage is to evaluate the most suitable bid sent by the providers using utility function. The negotiation mechanism is used to implement this stage.

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