Survey of Cloud Service Brokering

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Abstract- *Cloud computing offers wide variety of utility oriented services from different service providers. With the advent of cloud, users can avail the required services even without owning the infrastructure. However, the selection of required services from the available service provider is always a challenging task. In this paper, we attempt to introduce an intelligent cloud broker for simplifying the cloud service selection process. Also, the paper presents a comprehensive survey of research work in the phase of cloud service selection. Various research attempts have been discussed elaborately along with their limitations for further exploration. Finally, the paper emphasizes the need for the cloud broker in service selection phase. The novel idea has been strengthened by introducing an intelligent cloud broker for the existing cloud architecture to perform the effective selection and delivery of required services. Keywords - Cloud computing; Cloud service; Service selection; intelligent cloud broker; Service recommendation Machine.*

I. INTRODUCTION

The dynamic requirements which are potential in nature, raised by the stakeholders of the computing environment prompt the essential need of computational resources, environment, platforms and even business services also. Though the need for consumption is not often in nature, the outcome and important of such resources are highly demanded. A computing environment that offers on-demand, pay-as-per usage, utility oriented services to the end user has been emerged and deemed as a new sort of computing called 'cloud computing' [1, 2]. With the advent of cloud computing, users can avail their required services even without owning the infrastructure and capital investment. In this way, cloud computing promotes the computing and computational environments, a service of public utility where certain kinds of services are offered as a pay-and-use model in which the cost is proportionate to the demanded service and some of the services are even at free of cost. Some examples of cloud services are scheduling and task management of operating system level services, platform level services for designing and developing applications, provision of user access interface, web based API's, a programming framework for solving a complex problem and other value added deliveries. Broadly says, the service models offered by the cloud creates three major levels of abstractions namely 'Infrastructure-as-a-Service (IaaS)', 'Platform-as-a-Service (PaaS)', and 'Software-as-a-Service (SaaS)'. Based on service consumption, the user groups have been categorized as (i) Public cloud – Open access to the services are offered for all the public, (ii) Community cloud – Services are provided for the consumer's community of one or more organization, and (iii) Private cloud – Services are offered for the exclusive use of single person or an organization which comprises a lot of business units. The proper identification and selection of cloud services is a difficult process in the present cloud computing scenario. Many of the existing research works as shown in Fig.1, are focused on the methods such as Multiple-Criteria-Decision Making (MCDM), Analytic Hierarchy Process (AHP), Artificial Intelligence (AI), Ontological construct, Context based, Fuzzy logic based, and Opinion mining for the selection of cloud services from the cloud service providers.

II. RESEARCH EFFORTS IN CLOUD SERVICE SELECTION

Han and Sim [3] have developed a model based on cloud ontology for the discovery of service. The authors proposed the agent-based approach to finding out the sources of services, reduces unwanted surfing with many websites. The proximity of the detected services is considered for the construction of cloud ontology. The proposed ontology-based mechanism failed to compare the nature of services with respect to the service utility. Kang and Sim [4, 5] proposed their work based on cloud ontology to discover cloud services. With the reasoning concepts, the ontology for the selective discovery of services has been constructed. They simplified the searching process and offer the related services on time. The proposed ontology construction focused on the consumer requirements with the available service specification of the cloud provider. Lin et al. [6] proposed a broker based cloud model for the service selection process. As part of their proposal, they have developed an indexing tree (B-Tree) structure for the representation of cloud service providers. The author's concentration lies in the handling of service information rather than the decision of suitable services. The tree representation of the service information has expanded, if the service providers are increased. Joshi et al. [7] proposed their approach towards to the discovery and provisioning of public cloud services between the cloud user and provider. The consumers can use their proposed web portal for the

phase of service selection. However, their work focused on the server-centric feature and hence, there is no possibility for the composite selection of services. Talal et al. [8] introduced a Cloud Service Crawler Engine (CSCE) for discovering the services by using the constructed ontology. The proposed system performs the service selection and constructs the ontology with the available data for the discovery, validation, and categorization of cloud services. Ontology helps to discover and filter the appropriate reference links based on customer needs. All these works are carried out through the software code termed as an agent. Damiani and Fugini [9] developed a trader system as an intermediate for the client side. It is designed with the fuzzy concept, which includes the fuzzy ranking and selection methods. However, the proposed model allows the client rather than the agent to interact with the Trader. In later work [10], the authors reconstituted their model named as 'Intelligent Trader System', which includes the additional functions such as query transparency, parametric semantics, and ranked service with synergy management. Hence, the problem in the earlier model has been rectified and the clients can choose the best services from the ranked list. Sun et al. [11] addressed the problem of user's uncertainty in cloud service selection. Hence, a fuzzy-based system is developed to guide the users through their right service selection. They have constructed ontology for the similarity identification and used the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to ranking the top most services as per the user's choice. Esposito et al. [12] focused the improvement of service selection by the fuzzy set and Dempster-Shafer (DS) theory. The DS theory represents the generalization of the Bayesian theory of subjective probability. Finally, the Multi-Criterion-Decision Making (MCDM) has been used to select the services according to the TOPSIS ranking. Qu et al. [13] proposed a context-based service selection, which considers the subjective assessments of cloud user with the objective assessments predicted by the trusted parties. Normally, the context represents the location and time, and it is applicable to the mobile environment only. Even though the proposed work considers the user's feedback, it is difficult to predict the need for the cloud user with respect to their context information. In addition, the possibility of anonymous feedback may lead to destroying the right service selection of the new user. Nagarajan et al. [14] developed a fuzzy-based system for the selection of infrastructure (IaaS) type services from the multiple cloud service providers. In this work, the authors have considered taken certain QoS parameters such as 'availability, reliability, scalability, privacy, portability, and security' for evaluating the cloud services. In the requirements specification phase, they approached linguistic representation rather than the numerical way of instance specification. Through that, the problem of the unambiguous state of the new cloud users in service selection has been handled effectively. Wang et al. [15] proposed an adaptive learning based cloud broker for the dynamic cloud service selection. The authors reviewed their previous work and concluded that their work concentrates on the dynamic selection rather than static. In their work, the concept of Artificial Intelligence plays a major role in the construction of the Cloud Broker. However, the system fails to express the various kinds of user needs and its progress in service selection. Nagireddi and Shakti [16] dealt about the ontology construction of the cloud service characteristics as database description, which serves as a repository for various service offered by cloud service providers. The problem with this approach is, (i) the individual providers are responsible for registering with the inter-cloud registry and (ii) lacks in dealing the issue of automatic service findings.

A. The Need for Cloud Services:

Brokerage In cloud computing scenario, an intermediate layer that facilitates a smooth interaction between the cloud provider and user plays an active role and it leads to the concept of cloud services brokerage. The service brokerage layer enhances core cloud functionalities such as service selection, service integration, service aggregation, service customization, quality assurance, and service optimization. Besides the role of service selection, a cloud offers various stacks of services for service consumers. Hence, a typical software broker is needed for extending the brokerage concept for the improved service life cycle.

Automated Service Selection without User Intervention From the consumer perspective, the broker must be an intelligent to perform service selection and forecast the services with or without consumer's guidance. Hence, the traits of the broker must be improved. Though many works of literature provided all the basic capabilities and action list of the broker towards fulfilling various service parameters, certain challenges for the broker based cloud still exist. As a research focus, certain extended functionalities are to be introduced in the broker layer for enriching the service selection process. To cater this, an intelligent broker must be constructed for pre-processing, ranking, and constructing requirement ontology for the automated service selection process on behalf of the user. When service provider hosted new services, the broker can evaluate them based on user level. Hence, classification of users with respect to the requirements based on well-known soft computing benchmarks such as neural networks, fuzzy model, and supervised learning techniques are to be considered. Dynamic Service Composition It is quite a nature that not all the required services could be availed from a single provider's

space. It prompts the need for the research towards the design of intelligent cloud broker that facilitate the provision of composite services from a registered cloud vendor. Hence, techniques that facilitate effective broker-providers' interactions, followed by broker interactions are to be considered for dynamic service composition scenario. In this aspect, we put forward certain promising directions that include techniques based on multi-criteria decision making for availing composite services, unsupervised learning techniques such as clustering for segmenting federated services, intelligent collective discovery framework based on statistical principles and models. Comprehensive SLA model for Effective Budgetary plans since cloud users are differing with their requirements based on their budgetary plans, a comprehensive SLA model that fits for all sorts of cloud user is the need of the hour. It can be accomplished by techniques such as the adaptation of optimal cost estimation model using a genetic algorithm for resource utilization, the inclusion of multi-criteria decision techniques for designing attribute matrices for budgetary plans, delivering traceability metrics for effective mapping between posted requirements and stated budget. Issues related to Service Migration on Cloud In existing cloud broker, the operating principles are motivated towards to the normal selection and provisioning of services from a single provider. There is an opportunity to do these processes by performing the interoperability between the clouds. Without the interoperability nature of the cloud broker, it is impossible to do the migration of services from one cloud service provider to another for the benefit of the cloud user. It is also a major issue with respect to the design of intelligent broker. Issues related to Privacy However, the privacy emerged as a major issue in cloud computing, it must be properly handled while designing the broker. At any levels of functionalities, the user interface or business logic of the proposed broker should not try to extract the intention of the requirements while gathering, and post provisioning activities too. Hence, various service metrics are to be designed for handling privacy issues. Service up-gradation alerts According to consumer-broker SLA, the contract between the entities are transient in nature and it ends once the service life cycle has been completed. A broker that offers service up gradation alert even after the completion of the contract would be a novel choice by more consumers. It can be done with the aid of feature selection theory, rough set theory for implementing automated service up-gradation alerts by the broker.

III. DATA FOR CSBS:

Cloud Harmony is a commercial product, which provides four core services so that users can compare a large set of commercial cloud providers. Cloud Square allows users to directly compare the features of cloud providers, e.g., providers offering compute at 100% availability in Europe. Cloud Scores offers a set of benchmarking data for popular cloud providers; currently SPECint, SPECfp, Geekbench, Geek bench Multicore, Unixbench and Unixbench Multicore data are available. Cloud Match provides real time metrics for cloud providers, e.g., networking latency for all providers, upload speed etc. Finally Cloud Reports offers many of the previous services packaged into either quarterly or monthly reports. Cloud Harmony have a number of Web service (both REST and SOAP) APIs available, allowing application developers to utilise these metrics for cloud brokers. A recent EPSRC project [9] discussed a set of "fair" benchmarks for cloud computing systems. The report provides a comprehensive survey of existing benchmarking techniques and presents the results of performance benchmarking covering: Memory IO, CPU, Disk IO, Application and Network for Amazon, Rackspace, IBM and a private cloud installation of OpenStack. The research was motivated towards performance-based pricing schemes, e.g., paying more for better, or more reliable performance. The Yahoo! Cloud Serving Benchmark (YCSB) is an open-source framework for evaluating the retrieval and maintenance capabilities of NoSQL database systems.

Application Specific Brokering Each user wanting to deploy an application on the cloud has a different (and potentially unique) set of requirements. For example, while a developer of a Hadoop application requires that a certain number of tasks must be completed in a given time frame, an owner of a web server wants her application to be able to respond to any request within a certain amount of time, regardless of the current workload. Similarly, an organization with a high budget is able to pay a lot of money to minimize its application's execution runtime, while a small start-up might prefer a cheaper option, which takes longer to complete. As a result, it is necessary to have a cloud broker service, which takes into account an application's behavior in order to suggest the best options based on a user's requirements. As all applications behave differently, the decision made by a broker regarding one application cannot necessarily be applied to another. Developing a cloud broker which makes decisions based on application specific characteristics is challenging as it requires not only complete knowledge of both the application's behavior and cloud resource performance, but also requires a method, which can find the connection between these two data sets in order to make an accurate prediction. We advocate further research upon application modelling and workload classification, capture and prediction. Furthermore, instead of just maximizing performance or minimizing the execution cost of an application, a broker must be able to enforce a user-defined QoS property based on the application

model and predicted workload. Cloud Prophet and Matrix have taken some first steps towards this goal.

IV. CONCLUSION

Cloud computing emerges as a major source of the large-scale and complex computing paradigm. In this paper, we present a comprehensive survey on cloud service selection. Various research attempts along with their significance are accounted and limitations are highlighted with appropriate comments. The intention behind the paper is to promote the existing cloud environment into an intelligent one with the aid of proposed intelligent cloud broker. Accordingly, the cloud service brokerage concept has been highlighted with various open research challenges and recommendations. A proposed intuitive model with the inclusion of intelligent cloud broker and its desirable functionalities are elaborated in the penultimate section of the paper. As a future work, we plan to extend the proposed broker responsible for interoperable nature that suits for the federated cloud environment.

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