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Goal-Based Request Cloud Resource Broker in Medical Application

Mohamad Izuddin Nordin, Azween Abdullah, and Mahamat Issa Hassan

***Abstract*—**In this paper, cloud resource broker using goal-based request in medical application is proposed. To handle recent huge production of digital images and data in medical informatics application, the cloud resource broker could be used by medical practitioner for proper process in discovering and selecting correct information and application. This paper summarizes several reviewed articles to relate medical informatics application with current broker technology and presents a research work in applying goal-based request in cloud resource broker to optimize the use of resources in cloud environment. The objective of proposing a new kind of resource broker is to enhance the current resource scheduling, discovery, and selection procedures. We believed that it could help to maximize resources allocation in medical informatics application.

***Keywords*—**Broker, Cloud Computing, Medical Informatics, Resources Discovery, Resource Selection.

I. Introduction

MEDICAL Informatics application nowadays plays an important role in our daily life. There are various kinds of applications existed in the medical field such as content-based image retrieval system [1], collaborative decision-making [2], medical information system [3], etc. These applications can assist users (e.g. radiologist, physicians and other medical practitioners) in determining patient's history and also used for diagnostics and therapy [4].

To use these kinds of applications, the user needs to know what exactly resources are used and what kind of infrastructure are needed. There must be a middle component to mediate between the application's user and resources that have been requested. Grid resource broker [5-8] has been introduced by computer professionals to distribute computing power over internet for performing resources brokering and job scheduling. Numerous types of frameworks and algorithms have been proposed (Section II) in determining the best solution to discover available resources from heterogeneous machines in distributed environment [6].

After the cloud computing was introduced and has been receiving more attention than grid computing, the clouds generally offer users to access applications and resources on demand anywhere in the world [9]. In cloud computing, the infrastructure must be very robust and be available at anytime. Services provided by cloud computing need to be highly reliable, scalable and accessible from everywhere.

Authors are with Department of Computer and Information Sciences, Universiti Teknologi PETRONAS, 31750 Tronoh, Perak, Malaysia.
E-mail address: mohamad.izuddin@gmail.com (M. I. Nordin), azweenabdullah@petronas.com.my (A. Abdullah), mhtissa@gmail.com (M. I. Hassan).

This paper focuses on one application that is widely used in medical field i.e. the content-based image retrieval system (CBIRS). This application is used for executing queries based on the visual contents for browsing large multimedia repositories.

In medical field, digital images are produced in ever-increasing volume for diagnostics and decision making purposes. More than 12,000 images per day have been produced in Radiology Department of the University Hospital of Geneva [4]. These large amount of images need to be catered for everyday and at the same time, there are images that might be used by other radiologist from other hospitals.

The aforementioned problem has led to the idea of utilizing cloud resources broker to collaborate between the applications and resources provided. The cloud broker will be applied to optimize the use of resources in the cloud by goal-based request. In some cases, users in cloud computing may want cheapest cost of total resources available and some might need resources that meet their requirements regardless the quality of the resources. In a practical sense, the cloud users always aim to solicit cloud resources to optimize their needs. In this paper, we explain the idea of cloud resource broker in medical application by enhancing several existing algorithms and present our new architecture based on prior arts found in [6-11].

II. Background and Related Work

This section gives an introduction of resource broker and the related technologies that used it. Resource broker is a relatively new idea in medical environment. Previously, medical information were gathered and consolidated in conventional way via electronic health record (EHR). It have been used in organizations to integrate files of patient's history that medical practitioner generated [10]. The EHR has been an extremely active research area since 1990s by the US Institute Medicine. They studied the idea of electronic records as a platform to cater for the increasingly complex medical information required by professional users [12].

We present here some of the review articles that described the state-of-the-art of the respective years and contain the technologies used in broker at that moment in time together with their functionalities, techniques applied in discovering and selecting resources, scheduling techniques and also algorithms that are implemented. Several architectures related to grid and cloud broker have been studied for us to come out with new architecture that collaborate medical service broker in cloud infrastructure.

A. *MediBroker*

Guarracino et al. [7] describe MediBroker as a tool to search and discover in any cluster that can be merged with medical application (image reconstruction) within the time limit. In this context, broker is referred to a set of functionalities that allow discovery of resources in distributed computing environment in certain application and select any suitable resources that match with user specific needs. Those resources can be defined as computer operating system, data storage, CPU speed, hardware, software etc.

Two types of algorithms (discovery and selection) are introduced in order to discover the best registered resources which capable to solve the problem and to select one of them to meet user's requirements. Fig. 1 shows the simple way to read discovery algorithm. It requires user to enter type of OS, memory size needed and Globus MDF server to find registered and valid machine. The list of available machines will be the output for this algorithm. The important thing is, the list must be similar to user requirements.

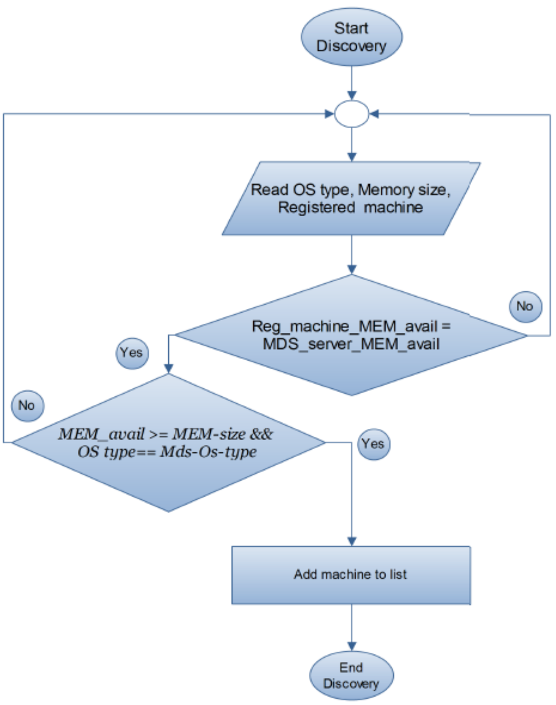

Fig. 1. Simplified flowchart of Discovery Algorithm [7].

This type of algorithm has a drawback as it can only cater for small number of resources. Complications arise if large amount of resources are involved. To handle this problem, the authors propose the idea of indexing the available and valid resources to MDF server which can assist resource broker to reduce time in the selection phase.

For selection algorithm, it returns the selected machines that can execute selection procedure within application time. Otherwise, it returns false value where no resource is available as depict in Fig. 2. CPU frequency, percentages of CPU usage, memory size of jobs and application time are the most important input parameters. Other input parameters and detail model to execute this process can be found in [7].

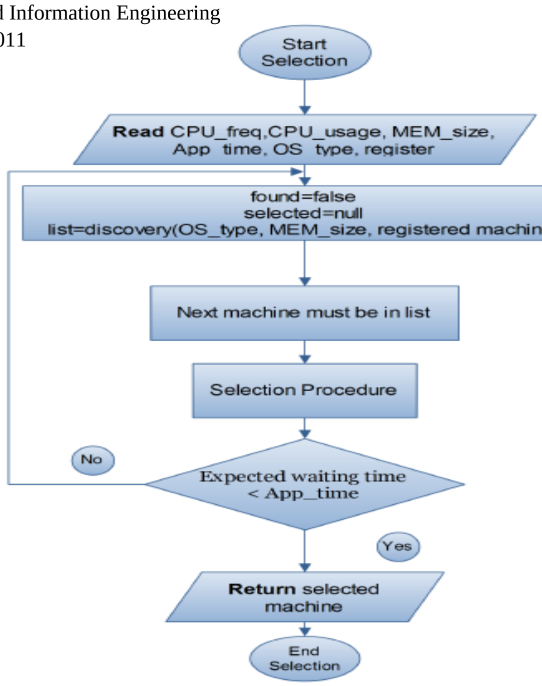

Fig. 2. Simplified flowchart of Selection Algorithm [7].

By implementing these two algorithms, the broker can only select jobs within a single cluster and not distributed enough. Therefore, modification and some enhancement are needed in both algorithms in order to employ distributed computing elements in real distributed networks and computation.

B. *Gridbus Broker*

Venugopal et al. [6] give an extensive description of scheduling job in resource broker by introducing Gridbus Broker. It consists of a strategy on resource scheduling in data grid by focusing on adaptive scheduling algorithms and brokering for different kinds of resources that are shared by large volume of user jobs.

The original architecture of Gridbus Broker is shown in [6] and Fig. 3 illustrates the simplified version which is focusing on grid scheduler. The scheduler gets input from a set of jobs together with a set of services nodes. It matches the job requirements set by user with the services nodes, then, it dispatches the job requirements to the remote node. Here, scheduling algorithm is applied. Jobs that require remote data need to retrieve information from network information services to schedule jobs by optimizing the volume data transfer involved.

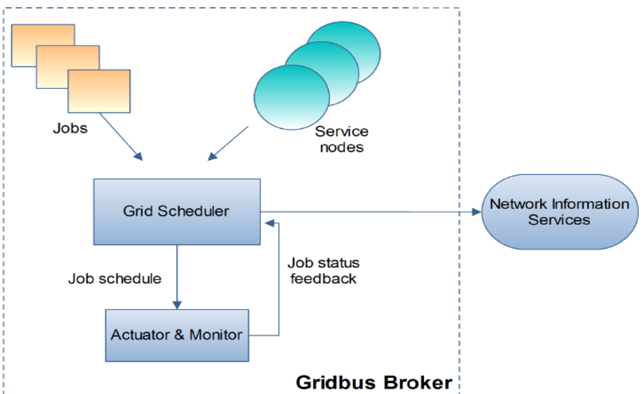

Fig. 3. Gridbus Broker which focusing on Grid Scheduler[6].

The algorithm for scheduler can be found in [6]. The function of scheduler is to minimize the amount of data transfer involved while executing jobs. It can be done by assigning jobs to compute servers which are close to the resources (sources of data) based on several factors such as capability and performance of resources, bandwidth available and the cost of data transfer.

This algorithm has contributed in this state-of-the-art by producing the best possible result by executing the jobs within the least amount of time. However, the drawback is without considering the location of data. The total time taken may be considered high. Some enhancement can be introduced when applying in cloud broker which we are going to propose in Section III. The result from this article can be a benchmark for our research.

C. IBHIS

The Integration Broker for Heterogeneous Information Sources (IBHIS) has been built as demonstration prototype in a research project of [10]. It investigates how the services model could overcome the weaknesses in an enterprise-based system. For instant, delivering important data through information broker service can be such a great deal. By using this kind of approach, data can be integrated from various autonomous agencies and at the same time it must be restricted to authorized or legal person only. This is in line with our research that allows only medical practitioners, radiologist and pharmacist to access the resource broker.

This article [10] introduces "data as a service" paradigm which allow a system for using a broker to deliver its services. It discusses more on the role of services inside IBHIS and how it works. The focus of reviewing this article is to observe the function of data- access service (DAS) and how it can be linked to proposed architecture in our research.

The DAS's responsibility is to transform the query (such as SQL) into local format, obtain appropriate data from multiple autonomous data sources, and return the data to the service broker. Besides that, each DAS comprises of semantic registry that can record every service description registered in it. It is good to create a data service that can be used by broker without requiring any detailed knowledge of how the data is controlled and administered. Latest progress of this IBHIS can be discovered in [13] as DAS Semantic Description file will consist of four conceptual categories purposely for data access control.

In a nutshell, the function of DAS is good to be implemented in grid where potential users could join the broker to provide their services. The drawback from this action is the data owner can restrict the usage of services provided to the certain number of data which has permission to see. It against the rule of cloud computing which data can be retrieved on demand as long as they pay for it and the data is available [14].

D. Service Level Agreement (SLA) Broker

The most complete overview of broker technology in cloud is given by Buyya et al. [9]. This article describes the concept of Service Level Agreement (SLA) that brokered between resources provider and the user. In order to use the resource provided in cloud, user must have different Quality of Service (QoS) parameters. Cloud provider will differentiate the user based on QoS to meet user's objective as agreed in specific SLA. There are basically four main layers in cloud service architecture as depicted in Fig. 4.

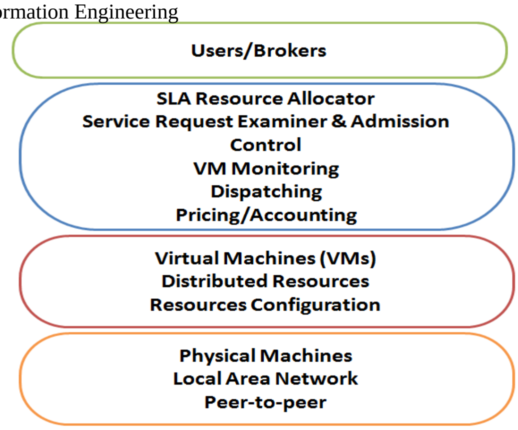

Fig. 4. Layered cloud architecture[9].

SLA Resource Allocator (SLARA) will act as interface between user and cloud service provider. User can submit service request to broker from anywhere they want before SLARA combines all components inside its layer to produce a metric agreed between user, broker and resource provider.

Then, VMs will take place virtually and connected to one physical machine in distributed environment to meet the accepted service request

The idea of cloud computing using virtual machines will be implemented in our research as resources (like hardware and software in cloud) will be served as a service. User must pay to use it by following the tariff that mutually agreed by the resource provider and the user. The cloud infrastructure can provide a platform for huge enterprises like hospitals and medical universities to handle their metadata and images with high performance computing systems[15]. By using this advance technology, they can use their capital investment just for operational cost and no need to pay for creating new platforms and large amount of money is needed to set it up and maintenance.

III. Methodology

This section gives an overview of cloud resource broker which is to be proposed in medical application. Initially, goal-based request concept presents as new algorithm in this resource broker. The goal is to optimize the use of resources in the cloud by maximizing resource allocation within cloud environment. The formation of this algorithm is motivated from earlier work on [11] where the concept of goal is applied. Goal, mediator and web service must be well defined using inbuilt keywords in order to reduce syntax burden for semantic web service (SWS) developer. Same goes to cloud broker where user needs to define goal in their request, and broker will act as mediator while cloud resources represent the web services.

In this paper, cloud broker architecture has been designed to fulfill the concept of goal-based request. Discovery and selection algorithm in resource broker will be enhanced to achieve research objective. An example of cloud resource broker in medical applications environment is illustrated in Fig. 5. Users are supposed to submit a request which capture a goal or desired resources via an interface.

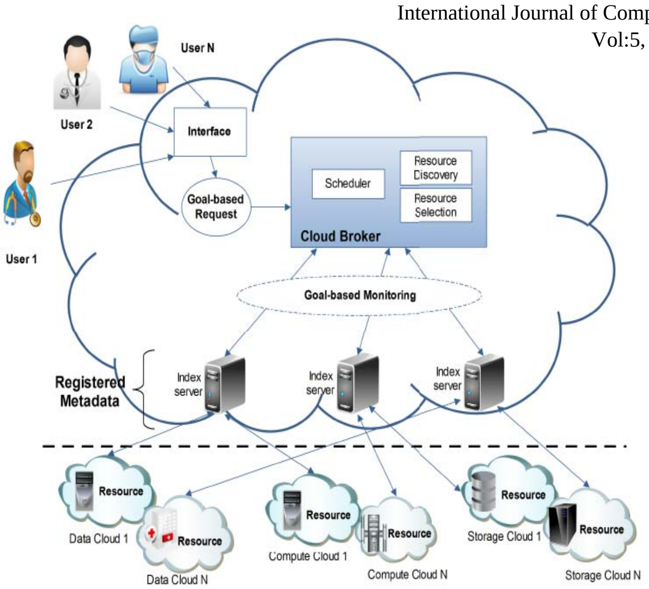

Fig. 5. An overview of cloud resource broker in the medical field.

The goal can be specific version of OS (i.e. Windows 7 Ultimate) rather than general type of windows, specific type of processor and specific size of memory and file storage. The interface is used as security where only authorized users from medical field can access the resources provided. By using goal-based request, a cloud broker will discover possible relevant resources, monitor whether user requirements are met or not, mediate any mismatch requirements, and select the best resources that match with incoming request.

Details of the propose architecture is showed in Fig. 6. Cloud broker comprises of two functions, resource discovery (RD) and resource selection (RS) which are handled by resource scheduler. The scheduler will execute RD by transmitting job to index server which is close to cloud resources to minimize the number of data involved. Index server will act as interface between cloud resources and cloud broker to discover what cloud resources are available. Every cloud resource must be registered in one or more index servers as the broker can easily identify nearest source of data which capable to meet user requirements through goal-based monitoring.

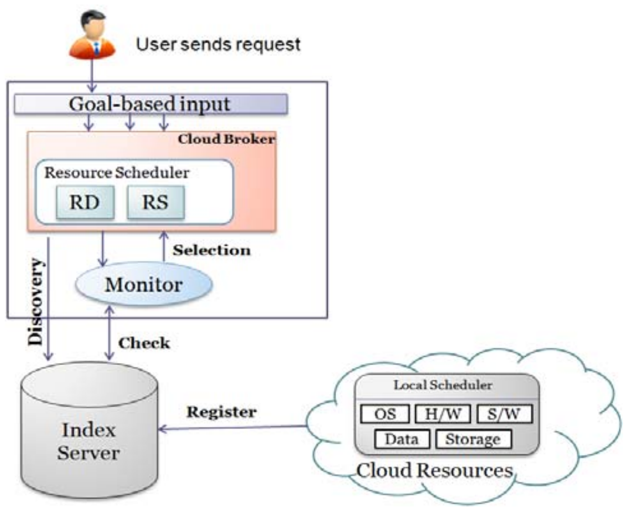

Fig. 6. Cloud broker architecture using goal-based concept.

The monitor will check whether the resource available is similar or not with parameters that have been set by user in goal-based request. If user requirements are met, scheduler will perform RS by selecting resource that best matches user requirements and send the selected resource to the respective user [16].

In medical informatics, we divide cloud resources into three categories which are compute cloud, storage cloud and data cloud. Compute cloud consists of resources like hardware, software, CPU and operating system while storage cloud provides database and large capacity hard disk to store digital images from radiology department located different places. All information regarding digital images and patients can be retrieved from data cloud as the data will come from experiment results from research universities and collaborative decision making systems. Local scheduler will be located in every cloud resource as it schedules user task by finding available resource (i.e. free processor or available amount of storage) to send it back to the user.

IV. Discussion

Referring to our proposed architecture, a method to optimally utilize the resources in the cloud is practically feasible. The proposed architecture has its own strength compared to other reviewed methods such that this goal-based concept architecture can support minimal human intervention in soliciting cloud resources for medical informatics applications. Resource allocations can be increased with reduced scheduling time to fulfill the intended resources (the goals) of cloud users.

Moreover, the proposed architecture is able to assist medical practitioners, physicians, and radiologist in retrieving important data from distributed environment, although they may be lacking in ICT skills.

V. Conclusion and Future Works

In this paper, we presented a cloud resource broker using goal-based request. This type of broker could be the potential solution in optimizing resource discovery, resource selection, and resource allocations in cloud infrastructure. This architecture is aimed to maximize/optimize allocation of resources to the user's desired goal(s).

Extended work is under development now to create a practical goal-based algorithm derived from the proposed architecture. This architecture is supposed to provide efficient solutions for matters discussed in this paper. Our architecture shall be proven by finite element modeling and benchmarking it with that in [6] in the context of scheduling. The findings and the expected results will be discussed in our future papers.

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