Subtractive Clustering based Distributed Gaussian Mixture Model for Density Estimation and Clustering in Sensor Networks ........................................... 414
JinSeok Ko, Manar Mohaisen, JaeYeol Rheem

<Part3>

An Efficient Block Replacement Techniques for Hybrid Hard Disk .............. 425
Jeong-Won Kim

A Context Awareness Model for u-Healthcare based on Artificial Neural Network ........................................................................................................ 433
Jeong-Won Kim

Smart Home and Cloud Interworking System (SHCI) Architecture Design for a Cloud broker based Smart Home Environment........................................ 441
Ga-Won Lee, Sang-Ho Na, Kyoung-Hun Kim, Eui-Nam Huh

Design of a Dynamic Collaborative Cloud System Model with Smart Brokering Technologies ............................................................................... 448
Young-Rok Shin, Myeong-seob Kim, Kyoung-Hun Kim, Eui-Nam Huh

Extraction of Feature Importance of Smartphone Usage with In-depth Interview ........................................................................................................ 455
MyounJae Lee, Ki Sook Ko

An Efficient Method for Human Movement Retrieval and Recognition Applications ........................................................................................................ 461
Minseok Choi, Sungwook Choi

A Study on Personalized Information Service based on Smart Phone ............. 470
Hee-Sun Kim

DRM Dilemma for Copyright Protection of Information on the Internet .......... 477
Joo Y. Park, Sung-Chul Lee

The Development of Location Information System using Wireless Fidelity in Indoors ........................................................................................................ 483
O-Byung Kwon, Kyeong-Su Kim

The Design and Implementation for New Move Picture Solution EZ-MOV Using FLV ........................................................................................................ 491
O-Byoung Kwon
Almost all existing cloud service models have been proposed and established using strategies to maximize the profits of service providers. However, the strategies are changing to satisfy user as well as service provider in case of emergence of cloud service brokerage. To solve unfair profit sharing problem, we propose a dynamic collaborative cloud system model with smart brokering technologies to allow the user to profit through collaboration of clouds, service integration and service-level agreements. This model will provide new business opportunities and we can discuss research challenges to realize the smart brokering architecture. We expect that the proposed model can be developed to realize a market-oriented cloud ecosystem.

Keywords: Cloud Service Broker, Service Integration, Refunding

1. Introduction

As user mobile devices such as smartphones have developed, cloud computing has developed in tandem to enable the remote computing environment. Many researchers have investigated ways to improve the services provided to users, and to extend providers’ service infrastructure in the cloud environment. Especially, market-oriented cloud computing environment with collaboration is proposed. As a result, a system was developed (SpotCloud [1], which is operated by Enomaly Inc.) in which users can buy cloud services without connecting to service providers.

However, there is no solution for how to manage an established market, including collaboration of service providers and delivery of service from the market to the user [2]. To solve this problem, the concept of cloud service brokerage [3] has recently emerged. Cloud service brokers can offer combined services, that is to say, the integration of many services from different providers, as well as information management for the sale of services in the cloud environment [4]. And the existing cloud service architecture has the problem that is focused on service provider to gain all profits occurred on cloud environment. To solve unfair profit sharing problem, we propose market-oriented cloud system model with smart brokering technology and user-centered pricing policy. We expect the proposed model to provide profits to the user as well as the cloud service broker.

The rest of this paper is organized as follows. Section 2 outlines the existing research on service pricing and its problems. Section 3 details the motivating scenario that informs our proposed approach; Section 4 describes the proposed market-oriented cloud ecosystem model with smart brokering. Section 5 presents a simple comparison between our model and two existing models. Section 6 presents our conclusions and directions for future research, including effects of the broker on the cloud environment.

2. Related Work

Enomaly Inc., a provider of software to create compute clouds, announced SpotCloud in 2010, a brokerage service that gives infrastructure-as-a-service (IaaS) providers a way to sell their excess compute capacity, and buyers a way to find smaller regional cloud providers for batch jobs. The service, which helps match supply and demand, as well as offer semi-elastic pricing (instead of elastic think of a belt analogy with several pre-cut holes offering a set number of sizes), is an initial stop in creating a true action-style delivery of compute capacity around the globe [1]. SpotCloud solves a problem,
especially for smaller cloud providers that want to sell capacity, but does not support a dynamic pricing policy, which would benefit the user.

Amazon EC2 Spot Instances is an example of a service that uses an elastic pricing policy to serve the user market for computing capacity [5]. The bidding price for EC2 instances changes in real time based on supply and demand. There are many research studies on dynamic pricing structures like Amazon’s spot price policy. However, the existing pricing policies are designed almost exclusively to benefit the service provider rather than the users, and do not focus on user profits. As mentioned above, most existing research on pricing strategy is based on maximizing the service provider's profits.

Cloud computing aims to provide QoS guarantee in dynamic computing environment to meet user's requirements. In order to ensure service of massive data transfer in cloud computing, the reservation and combined resources consumption become critical issues which include data, network and storage
resources. This issue involves reserving and assign combined resources to meet user’s QoS requirement. A service-oriented resource broker [6] is applied to discover select, reserve and assign best combined resources. Commercial cloud service providers (CSPs) make explicit commitments to their consumer by signing service level agreements (SLAs) [4], a contract between the service provider and the consumer to describe the CSP's commitment and to specify penalties if those commitments are not met.

A pricing strategy has been proposed to improve existing static pricing by considering the service user; however, this strategy also aims to maximize service fee revenue [7]. The service-level agreement (SLA) [8] is a structure for negotiation between service providers and users in the cloud market is mentioned in [9]. It also mentioned that profitable pricing through competition in the market, and a genetic method has been proposed to find the combination of services that maximizes profit. Furthermore, many other policies and research studies for service pricing include the software architecture to integrate SLA has been proposed in [10].

However, almost all previous studies have not considered the user (for example, see Refs. [11], [12]). In addition, as mentioned above, existing pricing strategies are focused on the providers' profitability. Hence, we propose establishing a smart brokering model for the user, including service pricing policies. This model can provide profits to the user through the functions provided by the broker, such as service integration and compensation for the user profits.

3. Motivating Scenario

The following scenario reflects the essential benefits behind the proposal of the market-oriented cloud system model with smart brokering.

In the cloud environment, there are many users who want to use multiple services at once, not a fixed service offered by a single provider. At first, they may intend to choose each service from different providers themselves, but unfortunately, the services from each provider have different SLAs, making it very complex to calculate service prices. So the users seek out a cloud service broker as an alternative means to access service providers (Figure 3).

![Figure 3. Motivating scenario](image-url)

We make the assumption that the broker is managing associated service providers and users for the monitoring and delivery of cloud services. We further assume that the user can send a service request to the cloud service broker, who then chooses the optimal combination of cloud services to serve this request. After choosing the optimal service combination, the broker generates a new SLA based on the existing SLAs from each service provider, which we call the Multi-Dimensional SLA. The Multi-
Dimensional SLA includes contractual definitions for pricing and for refunds resulting from violations. Thereby, user can take financial profits through our proposed cloud system model.

This paper aims to design a cloud service brokering model that addresses the following issues (see Figure 4): (1) establishing a dynamic cloud market for service extension by means of collaboration among service providers, (2) choosing the optimal service combination by integrating services among providers to satisfy QoS (Quality of Service) requirements, and (3) generating a Multi-Dimension SLA for reasonable pricing to ensure user profit.

![Diagram of Multi-Dimension SLA based Cloud Service Brokering Technology]

**Figure 4. Main issues of the cloud system model with smart brokering**

### 4. System Architecture

In this section, we will first describe cloud computing system architecture with cloud broker. In addition, we will present our proposed system architecture that is based on consumer-broker-server architecture. Our model has several administrators to handle their imposed task, which will be discussed later. To establish a cloud market, the three basic elements of cloud service provider, user and broker are required. Figure 3 also depicts the elements for establishing the cloud market in our system model; these elements can be divided into three parts as shown in Figure 5.

![Layering architecture of the proposed model]

**Figure 5. Layering architecture of the proposed model**
With this environment, consumers and broker agree upon a kind of commitment, such as amount of resource uses, pricing, quality of service (QoS) and SLAs. SLAs are those obligations between consumers and brokers. There have several advantages for cloud consumers as well as cloud service providers to use a third party cloud broker in a cloud computing environment. It can reduce the burden of the cloud consumers to choose the appropriate cloud service providers. In addition, cloud service providers don’t need to enforce more business policy to boost up their business. In fact, cloud broker assists both parties in several ways. More importantly cloud broker can earn some amount of money by assisting these two parties (i.e., cloud consumer and cloud service providers).

4.1. Establishing a dynamic collaborative cloud market

Existing single clouds are not well suited for serving large-scale services. Many researchers want to establish a large-scale environment through collaboration between cloud providers; for example, a horizontal collaborative cloud service approach has been proposed for the establishment of a dynamic collaborative cloud platform [2]. However, this platform does not include a manager, and would require a cloud service broker to manage the cloud market and extend services from each provider.

4.2. Choosing an optimal service combination by service integration

In a collaborative environment, the role of the broker is not linked between a service provider and a user. To offer efficient service, a cloud service broker must analyze providers’ services in real time and provide optimized combinations of services. For real-time brokering, service integration through negotiation with service providers must be accomplished automatically in real time, not manually.

4.3. Generating a Multi-Dimension SLA for reasonable pricing

The reason why the cloud service broker is needed in the cloud is that services have different SLAs for each provider. A combination of services generates a new integrated service, and a new SLA that we call the Multi-Dimension SLA. After generating this SLA, it is essential to audit for QoS and QoE to accurately monitor service delivery and pricing.

5. Comparison and analysis

In this section, we compare our proposed model with the other two models mentioned above, Enomaly’s SpotCloud and Amazon EC2 Spot Instances. To evaluate the models, we choose four comparison items: dynamic pricing, collaborative cloud service, multiple services and refunding.

<table>
<thead>
<tr>
<th>Table 1. Comparison with existing services</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Dynamic pricing</td>
</tr>
<tr>
<td>Collaborative cloud service</td>
</tr>
<tr>
<td>Multiple services</td>
</tr>
<tr>
<td>Refunding</td>
</tr>
</tbody>
</table>

The proposed cloud model provides all of the four comparison items. Enomaly’s SpotCloud does not support dynamic pricing, which is needed to calculate a reasonable price for using service. Even though Amazon EC2 supports dynamic pricing using a spot price, collaborative cloud service and multiple services are not provided through their cloud platform. In the near future, hundreds of service providers will compete to offer their services and thousands of users will compete to receive the services from service providers in the cloud environment. However, the existing cloud service platforms are suitable for offering complicated cloud services. The collaborative cloud will extend the scale of the cloud computing environment, but their platforms do not support it. Our proposed model is...
the first that adopts the concept of refunding. Refunding does exist in present models, but the terms are fixed before the services are provided.

6. Conclusion and future work

Business part of cloud computing is significantly challenging. As we are well informed that pricing is an unpredictable in IT business. Therefore, we have chosen this part and considered to provide a better solution. As we know, pay-as-you go pricing model is very much popular in cloud computing. However, pay-as-you go pricing model has several drawbacks in terms of fairness. Sometimes it violates personal and social fairness, and leads to impede the business.

To provide cloud services, large-scale cloud environments are established through collaboration between service providers. In these cloud collaborative environments, the concept of the cloud service brokerage emerges for building a cloud market. However, we predict that existing single-cloud-based services will not be applicable in near future and the cloud computing will be more complicated. For that reason, brokering services are needed in cloud environments. To solve the problem as we mentioned above, we present architecture for a cloud system model including smart brokering. In the proposed architecture, the cloud environment can provide new business opportunities such as on-demand provisioning, price optimization and service integration. Therefore we have shown that a smart brokering architecture is a viable business model allowing providers to realize a greater scale and reach than they could achieve individually.

In the near future, the scale of brokered cloud service is expected to reach approximately 350 billion USD in 2015. Despite this, there has been little research into the area of refunding. Accordingly, in future work we will extend our model and numerically analyze refundable cloud service to improve upon the current proposal.

7. Acknowledgement

This research was supported by the MSIP (Ministry of Science, ICT&Future Planning), Korea, under the ITRC (Information Technology Research Center) support program (NIPA-2013-(H0301-13-4006)) supervised by the NIPA (National IT Industry Promotion Agency).

8. References
