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A Cost Model for Hybrid Cloud

Shahla Sadeghani[1], Mohammad Jafar Tarokh[2]*
[1]Faculty of Computer and Information Technology Engineering, Qazvin Branch, Islamic Azad University, Qazvin, Iran
[2] Ph.D., Associate Professor, IT Group, Industrial Engineering Department, K. N. Toosi University of Technology, Tehran, Iran
Email: sh.sadeghani1989@yahoo.com

Abstract:- Cloud computing by providing on-demand services offers many benefits include reduced cost. For this reason many organizations gone to use of cloud computing. Due to problems with the use of hybrid cloud, in this paper, we proposed a cost model for reducing organization cost. The model is formulated by Binary Integer Programming (BIP) and according a hypothetical scenario is implemented in Games software. Our model for select the workload for has moved to the public cloud considered many parameters, including cost, security of workload, maximum utilization of the private cloud resources and managers can help of this model make the best decision about moving the workload to the public cloud. Our results illustrate which with the workload processing in private cloud and which of them moved to the public cloud and also specifies the best instances for processing them.

Keywords: Cloud Computing; Hybrid Cloud; Cost; Binary Integer Programming (BIP); Workload.

1. Introduction

Cloud Computing provides on-demand service. Due to the benefits achieved with the use of cloud computing, in the recent year, many organization gone to use of cloud computing. According definition of cloud computing provided by the National Institute of Standards and Technology (NIST) "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and

released with minimal management effort or service provider interaction" [1].

Cloud Computing delivers three categories of service include: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). IaaS is a delivery service model of Cloud Computing. IaaS refers to access infrastructure resources, including storage, servers, hardware and so on, over the Internet [2], [3]. Example of IaaS providers includes S3, Go Grid, Nirvanix [4], and FlexiScale [5], Google Compute Engine, Open Stack and Eucalyptus [3]. PaaS provide a Computing platform and higher level of abstraction in which application developers can create their own application over the Internet without download or install, using programming languages and tools supported by provider [6], [2], [7], [8]. Typical example of paas providers include Google App Engine, Microsoft windows Azure and Force.com [6]. SaaS refer to model that user without install the software on their devices can use of the service and application which provided by the service provider [9], [2]. Some of the popular SaaS provider include NetSuite, Oracle, IBM [10], SalesForce.com, Microsoft [10], [2] and Google App Engine [2].

There are four deploy model of Cloud Computing: private, public, community and hybrid Cloud. Each type of them contains benefits and drawbacks. Private Cloud which is also called internal Cloud [2] is implemented exclusively in an organization and accessible only by its member [11], [12]. The main advantage of private cloud is management of sensitive data and providing security and privacy. Since to build a private cloud, organizations should make a great investment, the major drawback of private deployment is its high cost. In the Public Cloud model, service providers offered resource as a service (Infrastructure, Platform and Software), publicly over the Internet to consumer [13]. Public Cloud reduce capital expenses, therefore are appealing for small and medium-sized enterprises [11]. In Community Cloud, several organization with similar objectives shared the cloud Infrastructure [14]. This model is more expensive than the public cloud, but offer higher level of privacy and security [15]. The combination two or more of cloud infrastructures (private, public and community) builds the hybrid cloud [16]. Hybrid cloud will overcome the limitations of each deployment model [2]. One of the benefits of hybrid cloud is that organization do not have worried about security, because they can maintain sensitive data in the private cloud and run other applications in a public cloud [2].

Today the number of cloud service provider has increased. Providers offer different type of service. Each provider has its own pricing policy,

that compared with the traditional method, this pricing model is more flexible [17], [18].

Amazon is one of the main providers of cloud infrastructure as a service [19]. Amazon Elastic Compute Cloud (EC2) provides three pricing models, on-demand, reserved and spot [20], with its own advantages and disadvantages. Amazon offers several types of virtual machine that said to be instantiated [21]. Each of them has a different amount of memory, core and storage, accordingly they are divided into different categories [22].

Organization to manage peak workload can benefit from hybrid cloud. The main challenge when using the hybrid cloud organization faced with that is, when the capacity of the private cloud will be completed, which one of the workload should be moved to the public cloud.

In this paper, we propose an optimal cost model by using Binary Integer Programming (BIP). This method selects workload for transferring to the public cloud and also select the best instance, with the aim of minimizing operating cost of the hybrid cloud. Finally, we show the working of the proposed method by applying it to a specific cloud scenario.

The remainder of this paper is organized as follows: Section 2 gives related works. In Section 3, we introduce the details and assumptions of our cost model for hybrid cloud. Then in Section 4 we formulate the problem. The obtained results of applying the model in a cloud computing scenario is shown in Section 5. Finally, conclusions of the paper are given in Section 6.

2. Related Works

In recent years, researcher has done studies in the field of Cloud Computing. Many of these studies have focused on optimizing the cost of cloud computing and hybrid cloud. A summary of these researches will be introduced in the remainder of this section.

Li et. al. [23] aims to provide a foundation for evaluating economic efficiency of cloud, offered criteria and formulas for the calculation of the cloud Total Cost of Ownership (TCO). Then developed their calculation and analysis approach into a web tool which is used in the internal cloud environment and demonstrate initially its analysis capability on the cost distribution and utilization imbalance factor. Truong and Dustdar [24] developed a service to estimate, monitor and analyze cost associated with scientific applications in the cloud. This service can be help scientists to decide which parts of their applications should be executed on cloud computing systems.

Kashef and Altman [25] offered a comprehensive, cost model for hybrid clouds by

the combined cost of data centers and the cost for using clouds. For calculated of the data transfer cost factor within the cost model, suggested to use a graph representation for the data transfer between services.

Bicer et. al. [26] developed a model-driven resource allocation framework to support both time and cost sensitive execution for data-intensive application executed in a hybrid cloud setting.

Juan- Verdejo [27] by stating that migration to a cloud-based architecture need to be compliant with enterprise and security policies' constraints while minimized cost, in his study presented a framework to assist in the migration following a hybrid cloud deployment decision which parts of the application should kept locally and which parts should be migrated.

Netjinda et. al. [28] proposed a new framework, where the number of purchased instance, instance type, purchasing options, and task scheduling are considered within an optimization process. The proposed system uses Particle Swarm Optimization (PSO) to minimize the total cost of using the cloud. Finally, by experiments found that the proposed system can be used to decide purchasing options for cloud consumers.

Nanth and Pillai [29] suggested a model to analyze the cost-benefits to decide upon the adaptability of cloud computing. The proposed model help to manage when decisions about adopting the cloud computing. Finally, with respect to the profitability of shifting to cloud computing, carried out a comparison across different organizations and found that cloud computing is profitable for small /medium scale enterprise.

Goyal [13] believed that organizations often feel confused, which model will fit best for their business. Therefor to help organizations take this decision, discussion, definition and compared the benefits and pitfalls of cloud deployment model.

3. Ontology-Based Learner Model

In this section we introduce the details and assumptions of our cost model for hybrid cloud.

3.1. Details and Assumption of Model

The purpose of this research is to provide a model to minimize the cost of processing workloads and help managers make decisions about transferring workloads to the public cloud.

We assume that an organization has a private cloud and since private cloud has a limited capacity, using the public cloud for managing peak of the workloads. Also assume that workloads are heterogeneous and independent of each other. In addition, workloads are includes security and normal workload that security

workload must be processed within the private cloud.

Order to process workloads is required for rental virtual machine from the cloud provider. Cloud provider offers various types of a virtual machine instance with different specifications and price. Customer rent this resource on demand from cloud provider and pays the cost of using this virtual machine an hourly. Amazon EC2 is included computational service provider.

In order to provide a cost optimization model, we offer a Binary Integer Programming (BIP) model. In the next section we describe the model formulation.

4. Problem Formulation

To Perform Optimization the total cost, Binary Integer Programming (BIP) is formulated. In the following we introduce the problem input data, decision variable, constraints and then define the objective function.

4.1. Input Data

The formulation requires the following input sets, which are listed below:

4.1.1. Available Capacity Of Organization Server

We assumed that the organization has a private cloud and amount of capacity available are as follows:

Q^{op} _ denoting the number of CPU cores

Q^{oh} _ denoting the Hard Drive capacity

Q^{or} _ denoting the amount of available memory

4.1.2. Instance Size of the External Servers

We selected k (k=1…p) instance. Each instance has parameters that are listed below:

Q_k^p - denoting the number of CPU cores

Q_k^h - denoting the amount of hard driver capacity

Q_k^r - denoting the amount of available memory

C_k – Fee in $ for running instance k for one hour.

4.1.3. Resource requirement of workload

We assumed that amount of resource requirements workloads are different in each period. We also assumed that have j (j=1…m) security workload and i (i=1…n) normal workload.

4.2. Security Workloads

U_j^{ap} – denoting the number of CPU cores required

U_j^{ah} - denoting the amount of hard required

U_j^{ar} - denoting the amount of Ram required

Normal workloads

U_i^{ap} – denoting the number of CPU cores required

U_i^{ah} - denoting the amount of hard required

U_i^{ar} - denoting the amount of Ram required

4.3. Decision Variable

The decision variable of optimization model are as follows:

If Xi set to 1, the normal workload i will run on the internal server; otherwise Yi set to 1 and means that normal workload i will run on the public cloud. In this case Zik also set to 1 and indicates number of instance that workload i will run on it.

4.4. Objective Function

The objective function represents cost of running workloads on the public cloud and it is define as:

$$\text{Minimize Cost} = \sum_{i=1}^{n} \sum_{k=1}^{p} C_k Z_{ik} \quad (1)$$

4.5. Constraints

Constraints of the optimization model introduced the following:

$$\sum_{i=1}^{n} U_i^{nh} . X_i + \sum_{j=1}^{m} U_j^{ah} \leq Q^{Oh} \quad (2)$$

$$\sum_{i=1}^{n} U_i^{np} . X_i + \sum_{j=1}^{m} U_j^{ap} \leq Q^{Op} \quad (3)$$

$$\sum_{i=1}^{n} U_i^{nr} . X_i + \sum_{j=1}^{m} U_j^{ar} \leq Q^{Or} \quad (4)$$

Eqs.(2)-(4) Ensure that maximum use of private cloud.

$$U_i^{nh} Y_i \leq \sum_{k=1}^{p} Q_k^h Z_{ik} \qquad \forall i = 1 \dots n \quad (5)$$

$$U_i^{np} Y_i \leq \sum_{k=1}^{p} Q_k^p Z_{ik} \qquad \forall i = 1 \dots n \quad (6)$$

$$U_i^{nr} Y_i \leq \sum_{k=1}^{p} Q_k^r Z_{ik} \qquad \forall i = 1 \dots n \quad (7)$$

Eqs.(5)-(7) Ensure that workloads according to amount of resources required assigned to most appropriate instance.

$$X_i + Y_i \qquad i = 1,2, \dots, n \qquad (8)$$

Eq.(8) Ensure that normal workload i will run only within the organization or in the private cloud.

$$\sum_{k=1}^{p} Z_{ik} \leq 1 \qquad \forall i = 1 \dots n \quad (9)$$

Eq.(9) Ensure that selected only one instance for processing workload in the public cloud.

$$X_i ; Y_i ; Z_k ; Z_{ik} = 0,1 \qquad (10)$$

Eq.(10) Ensure that required variables have binary values.

5. Experiments And Results

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To evaluate our model, we assume a small scenario and implement it in the Games

software. In this scenario we assumed that organization have 11 workload in two hours that characteristics of the workloads are shown in Table 1. Since security workloads are processed only within the private cloud and model not decision about moved them to the public cloud, in order to ease understanding of the model output, security workload have not been numbered. Also, according to model runs for each hour, numbering of workload started from one in each hour.

TABLE 1. Characteristics of the workloads

number	type	resources required			Time
		CPU (core)	Ram (GB)	Hard (GB)	
-	security	4	32	300	First Hour
-	security	4	12	200	
1	normal	2	10	100	
2	normal	4	3	200	
3	normal	4	3.5	100	
-	security	4	12	100	Second Hour
-	security	2	32	200	
1	normal	1	4	100	
2	normal	8	10	200	
3	normal	2	15	100	
4	normal	2	18	200	

We considered amazon as a service provider. Characteristics and cost of instance are shown in Table 2.

TABLE 2. Characteristics of Instances

num	Instance name	CPU (core)	Ram (GB)	Hard (GB)	On-demand (per-hour)
1	m1.medium	1	3.7	410	0.14
2	m1. Larg	2	7.5	840	0.23
3	c1.xlarg	8	7	1680	0.65
4	m2.xlarg	2	17.1	420	0.30
5	m2.2xlarg	4	34.2	850	0.55
6	m2.4xlarg	8	68.4	1680	1.11

Capacity available of private cloud is shown in Table 3.

TABLE 3. Capacity of private cloud

Capacity	CPU (core)	Ram(GB)	Hard (GB)
	12	48	500

The results of the model output in first hour is shown in Table 4.

TABLE 4. Result of model

Workload number	Dedicated instance	Instance name	Cost of instance	Toatl cost
1	4	m2.xlarg	0.30	1.40 ($)
2	5	m2.2xlarg	0.55	
3	5	m2.2xlarg	0.55	

Sine all three of normal workload in first hour moved to the public cloud, we can be concluded that peak occurred in the first hour. The most appropriate instance for processing of workloads are considerable of Table IV. The total cost of running workloads in the first hour is equal to 1.40 ($).

The results of the model output in the second hour is shown in Table 5.

TABLE 5. Result of model

Workload number	Dedicated instance	Instance name	Cost of instance	Toatl cost
2	6	m2.4xlarg	1.11	1.96 ($)
3	4	m2.xlarg	0.30	
4	5	m2.2xlarg	0.55	

According to the results of model output in the second hour, one of the four normal workload processing in the private cloud and the others normal workload moved to the public cloud. The total cost of running workloads in the second hour is equal to 1.96 ($).

6. Conclusions and Future Work

In this paper, we propose a cost model for hybrid cloud that can help to manager about moving the workload to the public cloud. The advantage of this model is to identify peak in the each hour, addition to ensuring processing security workload in the private cloud and maximum utilization of private cloud resources, select most appropriate workloads to move the public cloud and the most appropriate instance for processing of them in the public cloud.

In the future work we can consider other parameters of cost, including transfer data to the public cloud and storage.

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