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Optimization of Cloud Costs

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ABSTRACT

A large number of companies and organizations nowadays are making the decision to migrate their applications to the cloud. The resources needed to host their applications are provided by a cloud provider. It determines the price for the resources according to certain criteria. The users of the services pay for the costs depending on the resources they use. After the migration to the cloud, the consumers of cloud resources should try to optimize their costs. This paper presents several methods that we can use for optimization of cloud costs. In addition, it is provided a real case study of application of these methods in practice. According to the obtained results, cloud costs are reduced by about 65%.

KEYWORDS

Cloud, costs, costs optimization, cloud computing

1 Introduction

Cloud technologies are increasingly used nowadays. A large number of organizations and enterprises are planning or have already migrated their systems to the cloud. A migration of Moodle LMS of Goce Delchev University to the cloud is presented in [1]. Spotify, one of the leading media service provider in 2016 migrated everything from on-premises to the cloud [2]. In the same year, Netflix, one of the most famous streaming services, announced its cloud migration [3]. Capital One, a top ten bank in the U.S financial services industry, in 2020 reported their full migration from the on-premises data centers to the cloud including all applications and data [4]. There are a lot of other case studies for transition from own data centers to the cloud [5] [6].

Cloud technologies have a lot of advantages. Some of them are: scalability, flexibility, cost savings, work from anywhere, automatic updates, security, disaster recovery and so on [1] [7]. One of the listed benefits is cost savings. This is one of the first questions that all those who want to make a cloud migration ask themselves. Although this is certainly important, it is not the subject of this research. The purpose of this research is how to reduce the costs

after the migration to the cloud. This is very important for organizations and corporations in order to save as much money as possible. To achieve this, they must optimize the resources they use.

There are several studies that address this topic, but not all of them cover all the methods that can be used for optimization of cloud costs. Weintraub and Cohen in [8] present a model that is used for finding optimal combination of service providers to minimize the cloud costs. They propose three strategies for implementation of the model in organizations. Chaisiri et al. in [9] proposed an optimal cloud resource provisioning algorithm for allocation of resources that are offered by multiple cloud providers. Qi et al. in [10] present a novel cloud service cost optimization method considering multiple impact factors. Netjinda et al. in [11] proposed a new framework for cost optimization where the number of purchased instances, instance type, purchasing options and task scheduling are considered in the optimization process. Osypanka&Nawrocki in [12] present a novel approach for cloud costs optimization using machine learning. They also provided an experimental evaluation of their solution. Couthino et al. in [13] proposed a solution for optimization of cloud resource management in order to reduce payment costs and the execution time of user applications. Kokkinos et al. in [14] present an algorithm for cost and utilization optimization of Amazon EC2 instances. Deniziak et al. in [15] proposed a methodology for cost optimization of cloud real-time applications, which are conformable to the Infrastructure as a Service (IaaS) cloud computing model.

In our paper we present a comprehensive approach for cloud costs optimization. Several methods for effective cloud costs management are discussed. The rest of the paper is structured as follows. Section 2 presents the purpose of our study. Section 3 describes the research methods for costs optimization. The findings and the results of the application of cloud costs optimization methods are shown in Section 4. The last Section 5 is for conclusion and recommendations.

2 Purpose of Study

The main purpose of this paper is to show methods for reducing the costs for resources that we use in the cloud. This research is about costs optimization of resources that implement the IaaS model of cloud computing. This model includes the IT infrastructure that is needed for our applications to work properly such as: compute, storage and networking resources. All these resources are provided, hosted and maintained by the cloud provider in its own data centers. Cloud providers specify theprice for the resources. It may vary depending on the providers and the calculation method. What is important for us as users is to provide resources that will be sufficient to run our applications and have lower costs.

3 Research Methods

After making the decision to migrate applications to the cloud, it is in our interest to monitor the costs that we have for the allocated resources. What if the costs are high? How should we react in this case so that we can fit into our budget? For this purpose, there are several methods that can be used to optimize the cloud costs [19]:

- Identification of unused or idle resources

We must identify the resources we no longer use and no longer need [16] [17]. There is no reason to have costs for them. It is also desirable to discover the resources that are used very little and to use fewer instances to consolidate their computing jobs [18].

- Right-sizing of resources

With right-sizing we can modify the resources in the most efficient way [20]. One example of this is the optimization of servers for memory, storage capacity, computing, throughput, database, etc. This will provide resources with optimal performance in relation to the applications that use them.

- Using appropriate reserved instances and savings plans

Reserved instances are instances for which we pay in advance and reserve for a specific period of time, usually one or three years. Using this method, we can save up to 75% of our costs, which is really useful for every organization [19][21].

- Using Spot instances

Spot instancesare unused VM instances which can be used for a lower cost than the normal on-demand price. They are useful for error-tolerant or flexible applications such as analysis of data, background processing, batch jobs and jobs that get done quickly [22] [23].

- Reduction of data transfer costs

Some services include costs for moving data in different regions, availability zones or between different cloud services. That is why we need to reduce or avoid unnecessary data transfers [24].

- Using cloud native design.

Cloud native applications are deployed andhosted in the cloud [25]. They have all the benefits of the cloud such as: resiliency, flexibility, scaling, etc. The cloud native design offers the following features: microservices, containers, APIs, immutable infrastructure and so on. One example is a system with auto-scaling option. We only pay for the servers that we use according to specified rules and with this we provide costs optimization.

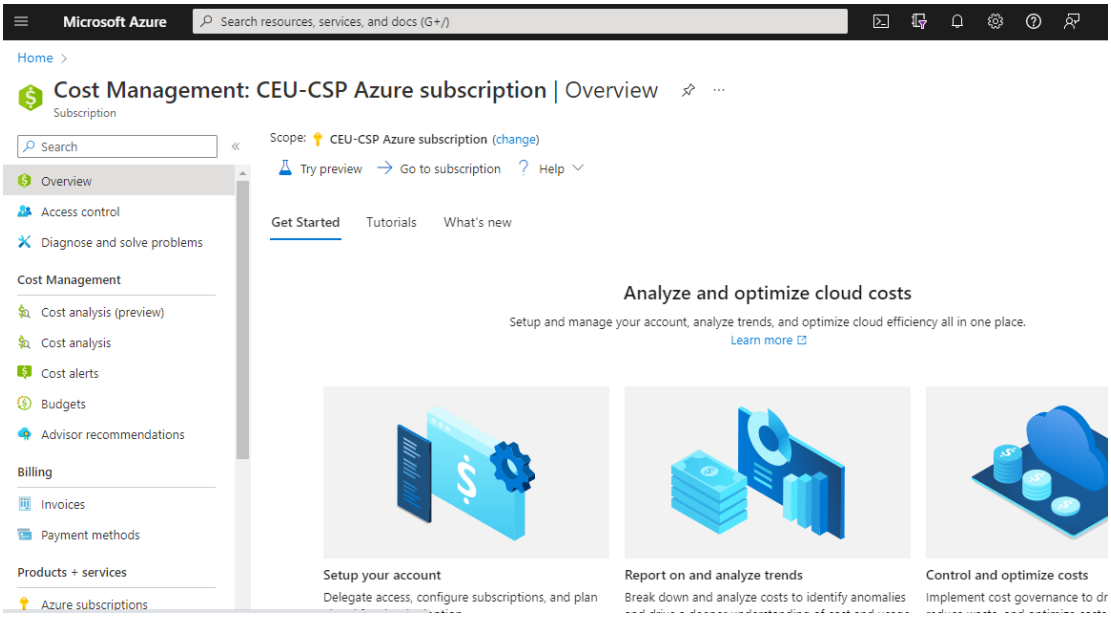

Figure 1. Cost Management tool from Azure platform

Cloud providers offer special tools for monitoring and controlling cloud costs. One such tool is the „Cost Management" in Azure (Figure 1). With the „Cost analysis" option which is part of Cost Management, a variety of analyzes can be provided, such as: accumulated costs by month, service name, region location, resource group name, etc. Using this option, we can also see the actual costs, forecasted costs and the budget if it is provided.

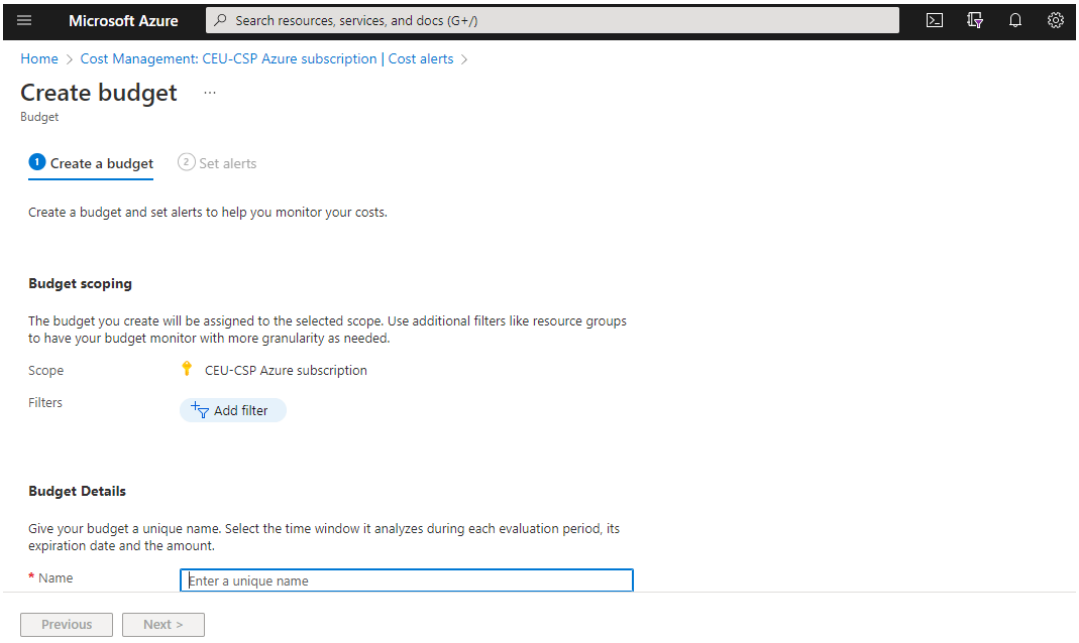

Figure 2. Cost alerts in Azure

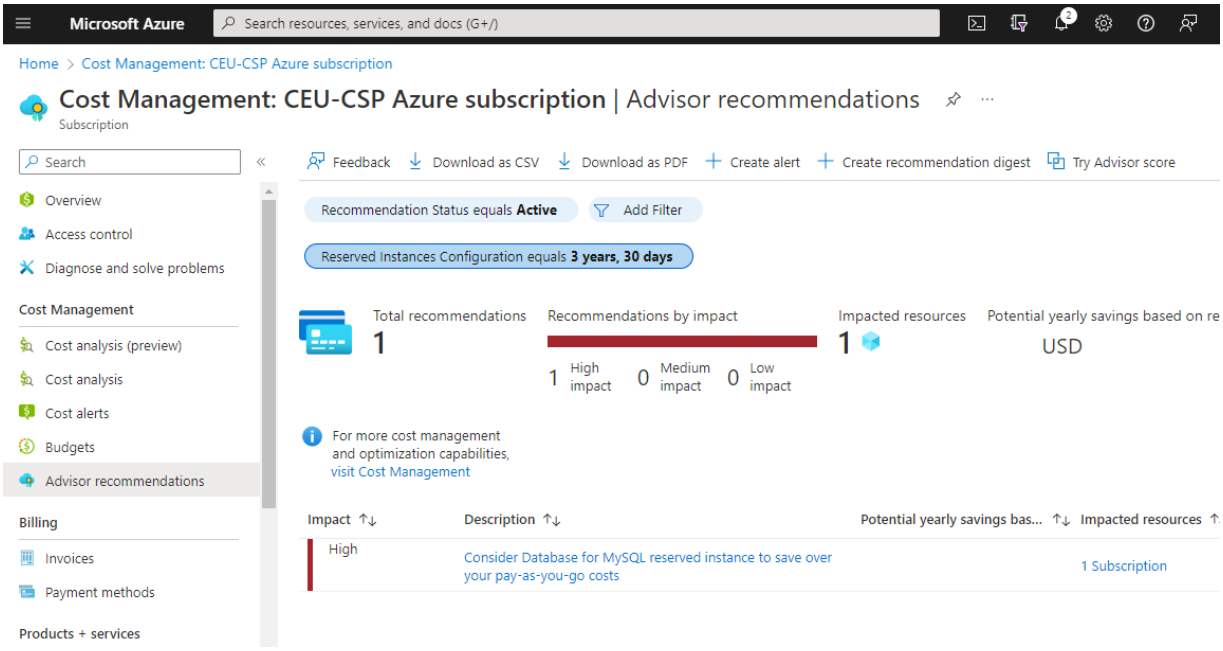

Figure 3. Advisor recommendation in Azure

What is interesting in Azure is that it has the ability to create alerts in case the costs are greater than a predefined budget (Figure 2). Another option that is part of the Cost Management tool is „Advisor recommendations", which gives us advice for optimization and control of the costs (Figure 3).

4 Findings and Results

In 2021, at University Goce Delchev - Shtip, we made a migration of some of our applications from on-premises to the cloud. As a cloud provider we used the Microsoft Azure platform. The cloud configuration for all applications can be seen in Table 1. First, the migration was done for 4 applications (Application 1-3 and Application 5). After 3 months the migration was done also for Application 4.

Table 1. Cloud configuration for all migrated application

Application	Operating System	Instance type	Database	Data Disk:	OS Disk
Application 1	Linux (Ubuntu 18.04)	Standard DS2 v2 (2 vCPUs, 7 GB RAM)	Azure for MySQL (v.5.7) Single Server General Purpose, 2 vCore(s), 100 GB Storage	128 GB Premium SSD LRS	30GB Standard SSD LRS
Application 2	Linux (Ubuntu 18.04)	Standard B2s (2 vCPUs, 4 GB RAM)	Local MySQL database	256 GB Standard HDD LRS	74GB Standard SSD LRS
Application 3	Linux (Ubuntu 18.04)	Standard B1s (1 vCPUs, 1 GB RAM)	Local MySQL database	/	128GB Standard SSD LRS

Application 4	Linux (Ubuntu 20.04)	Standard B1s (1 vCPUs, 1 GB RAM)	Local MySQL database	32 GB Standard HDD	30GB Standard SSD LRS
Application 5	Linux (Ubuntu 20.04)	Standard B1s (1 vCPUs, 1 GB RAM)	Local MySQL database	/	40GB Standard HDD LRS

During our cloud experience, we tracked the costs we incurred for the resources over a 1-year period (October 2021 – October 2022). For this purpose, we used the Cost Management tool from Azure portal (Figure 1).

In the first three months, the costs were slightly higher than expected. That is the reason why we decided to apply methods for optimization of cloud costs:

- *Identification of unused or idle resources* – Before the migration of our applications to the cloud, we created multiple test instances. We used these resources to test the behavior of our applications before they were released into production. To reduce the costs, we deleted these test instances.
- *Right-sizing of resources* – For applications that are not used frequently, we performed appropriate adjustments to the performance of the instances. We changed the type of the instances with lower performance in order to optimize the costs.
- *Using appropriate reserved instances and savings plans* – According to our research, after the third month of the migration, we decided to perform a 1-year reservation for our instances.
- *Using Spot instances* –We have not used spot instances yet, but in the future we plan to use them as test instances in order to reduce our costs if we create new instances that are not reserved.
- *Reduction of data transfer costs* – Data transfer primarily depends on the application that we used. We did not identify any unnecessary data transfers and that is the reason why we did not apply this method to reduce cloud costs.
- *Using cloud native design* – For one of our most demanding applications, we initially used Virtual Machine Scale Set (VMSS) and load balancer for auto scaling. Regarding the given scaling rules, we determined that we did not have inclusion of additional instances. This is the reason why we continued to use regular virtual machine. If you have a large number of users and requests, it is recommended to use auto scaling instances with appropriate rules.

With application of these methods for costs optimization, we observed a reduction in costs. Average costs in the period after costs optimization from January to March 2022 have been reduced by about 65% compared to the period from October to December of the previous year when the optimization methods were not applied. The average costs for the next three months, April-June, are also reduced by about 65% compared to the reviewed months of the previous year. The costs for July are similar to the other monthly costs after the optimization.In the period from August to October, three new applications were added in

Azure (Table 2). This is the reason why the costs have increased. The average costs in the period from August to October have increased by about 76%compared to the average costs of the previous three months. In the next period, we will make a reservation for the newly added instances to reduce the cloud costs.

Table 2. Cloud configuration for the three newly added applications in the cloud

Application	Operating System	Instance type	Database	Data Disk:	OS Disk
Application 6	Linux (Ubuntu 20.04)	Standard DS2 v2 (2 vCPUs, 7 GB RAM)	Local MySQL database	/	128GB Standard SSD LRS
Application 7	Linux (Ubuntu 20.04)	Standard B1s (1 vCPUs, 1 GB RAM)	Local MySQL database	/	30GB Standard SSD LRS
Application 8	Linux (Ubuntu 20.04)	Standard B2s (2 vCPUs, 4 GB RAM)	Local MySQL database	/	30GB Standard SSD LRS

5 Conclusion and Recommendations

Optimization of cloud costs is very important for users and organizations who have migrated their applications to the cloud. The savings that will be provided can be used for allocation of new resources or other investments. In this paper we present several methods that can be used for cloud costs optimization. We will focus our future research on finding new costs optimization methods.

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