SEEJSD

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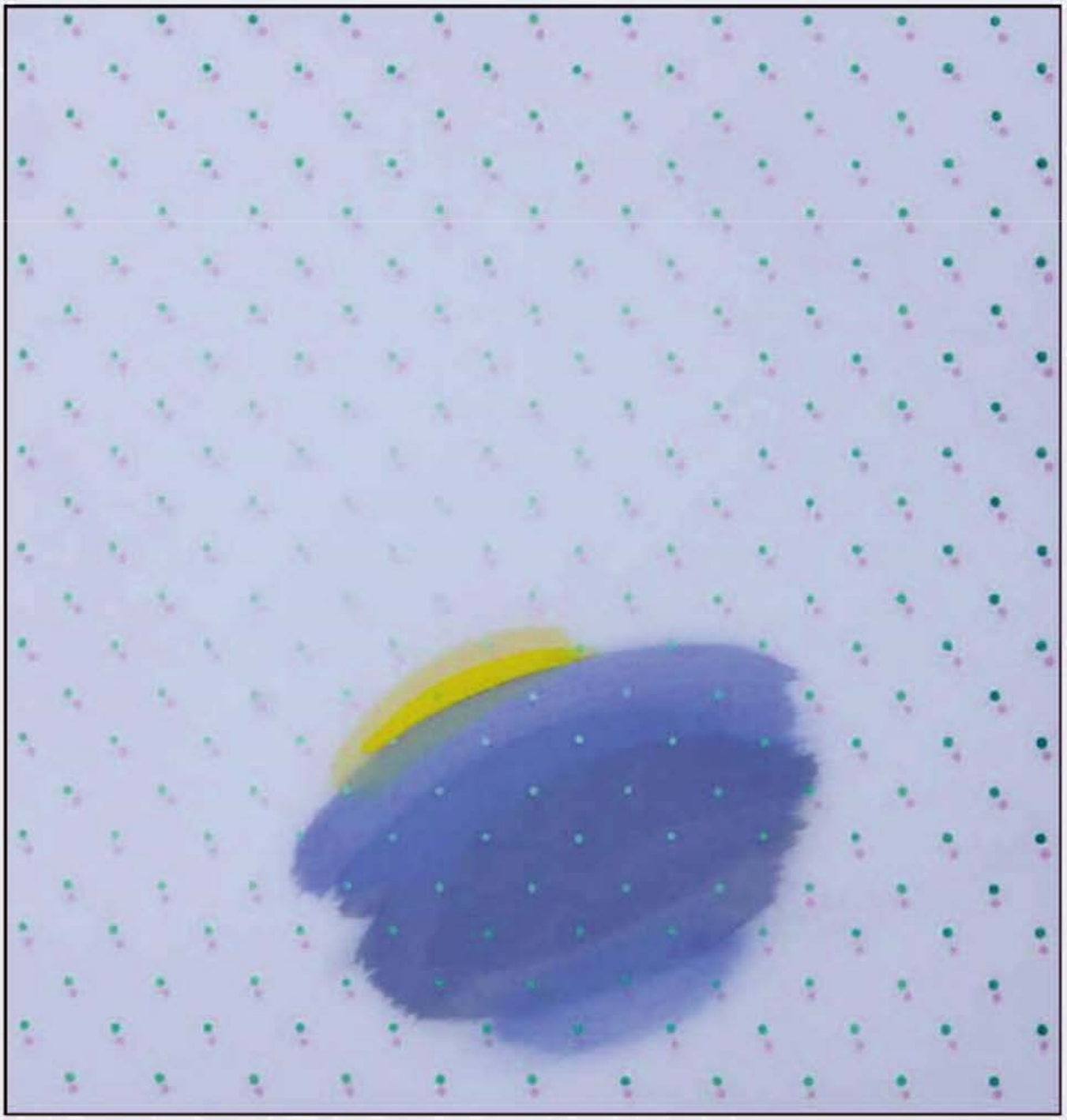

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Editorial

Two main attributes ubiquitous to dedicated researchers are the curiosity to explore novelties and the ability to anticipate changes of circumstance in their field. Over the past year, humanity has been shaken into alert by a historic wake-up call and made to face what has doubtlessly been one of the greatest challenges in its existence. The pandemic caused by the coronavirus has brought about tectonic changes in all segments of daily life and moved the symbolic Doomsday Clock closer than ever to apocalyptic values in its measure of global risk. Moreover, a pervasive speculation is that humankind must brace itself for similar and potentially even more dramatic challenges in the future. As well as the whole world, the Republic of N. Macedonia and its citizens felt on their own skin the unrelenting vehemence of the pandemic through lost human lives, economic collapse, inadequate education, desocialized, isolated and lonely population, and neglected social activities such as science, culture, sports, art and many others.

As with any major global event of little or no precedence throughout history, an enterprise that had to act promptly to deal with this catastrophe was science. Despite all the fascinating advances of science over the past centuries and decades, science's response to the pandemic has, dishearteningly, been neither rapid nor fully effective. On the contrary, the inevitable spotlight on the functioning of the scientific ecosystem has at once shone a light on all the civilization’s imperfections, even in the world’s most developed countries. The lesson we need to learn from this plague is that civilization needs a new concept of life based on solidarity and knowledge. The future will no longer tolerate or sustain improvisations and subterfuges that will return to humanity like a boomerang.

In such circumstances of bridled activity, everyone, including researchers in science and academia, has endeavored to continue to function by contributing to overcoming this global crisis. The impossibility of performing direct research and gaining first-hand experiences in many fields seems to have left more time for scientists to pause, reflect and overview their previous research engagements and to determine new directions for their further action in the field of science. So we, in the Editorial team of SEEJSD, continued to publish new achievements related to sustainable development, a continuity that has seen the Journal celebrate its fifth anniversary of promoting the dissemination of quality research across Southeastern Europe. We are not pausing at this milestone; rather, it gives us additional momentum to work towards the establishment of SEEJSD as an internationally recognized journal indexed in international databases of scientific publications.

I sincerely expect that in the coming period the situation will slowly return to normal and that, with lessons learned from this bitter experience, we will come out stronger and better equipped to overcome any future challenges that our society may face. Finally, allow me, dear authors, editorial board members and followers of SEEJSD, to wish you good health and hope for a better tomorrow.

Cordially,

Dr. Azis Pollozhani, PhD
Editor-in-Chief

Contents

Migration of Moodle instance to the cloud - case study at Goce Delchev University

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Abstract

The benefits of cloud technologies for Learning Management Systems (LMS) are enormous. Cloud services can provide a better user experience and greater flexibility. Moodle with about 250 million users is one of the most widely used LMS, which also has a cloud-based version. During this period of the Covid-19 pandemic, the use of this system is intensified. Many universities, schools and organizations have started to conduct most of their learning activities online. This has increased the number of Moodle users. At the Goce Delchev University - Shtip we have been using Moodle for 10 years. In order to be able to serve all the requests of the users, good servers and infrastructure are needed that will provide uninterrupted access. On-premises servers often cannot provide good scalability. Cloud technologies offer huge opportunities in this regard. The scaling they provide is extremely important when systems have an increasing number of users. So, we had to think about migrating to the cloud. This paper presents the possibilities of cloud technologies as well as the procedure for migration of Moodle instance to the cloud.

Keywords: *Moodle, Learning Management Systems, Cloud, Covid-19.*

1 Introduction

Compared to the past, today sharing knowledge and learning is much easier. At this time of Covid-19 pandemic this is very important for the continuation of the educational process. The Internet and the Learning Management Systems (LMS) have the greatest impact on this. The Internet has greatly helped educational systems by introducing the term e-learning. LMS is a software that is used to create, manage and distribute educational content. Basically, a learning management system consists of several components or modules: course management module, student management module, online examination module, online assessment module, online course material management module and feedback management module [1]. Each of these modules has its own function. There are a number of LMS today. Some of them are open source such as Moodle, ATutor, Sakai, MyGuru2, Claroline, while others are commercial such as Blackboard, SumTotal, Litmos and Connect Edu. According to [2] the recommended open source LMS is Moodle. This conclusion is based on the features offered by Moodle. According to [3] where a comparison of 6 open source LMS is made, Moodle and ATutor have the best communication tools with user friendly interface.

Moodle is one of the most used LMS. During this period of pandemic, the usage of Moodle has significantly increased. At the beginning of the pandemic, in March 2020, the number of users was around 190 million, while the number of Moodle sites was 145000[1]. Now Moodle has about 250 million users and 197000 sites[2]. 18104 participants have been trained in Moodle Admin Basics, of which 14174 first accessed it when lockdowns starting taking place. 4263 new educators have joined Learn Moodle Basics program for teachers. There were 4504000 active devices on the Moodle App in the last month, vs 1305000 this time last year. 15 million more new activities are being created on registered Moodle sites in the last month, compared to the previous month. Moodle Cloud has 1.67 million new learners now vs 453000 last year[3].

At Goce Delchev University, we have been using Moodle LMS for about 10 years. The current version of Moodle we use is 3.9.2+. Our LMS has 8336 users, 1620 courses, 16179 resources, 51091 posts and 66977 questions. The E-learning department manages all activities for the platform. All the materials for learning are placed by the teaching staff in the created Moodle courses. Students using the Internet can access them anytime, anywhere. About 5 years ago, our university decided to conduct elective university courses electronically through the Moodle e-learning platform [4]. In the period from 2014-2015, most of the teaching staff participated in the trainings for creating electronic tests [4]. These trainings contributed to the readiness of the teaching staff to conduct e-testing in this period of pandemic. Most of the exams in this period are conducted electronically through our e-learning system.

Our Moodle site was hosted on a on-premise server, which could not provide good scalability. The problems arose due to the increasing number of users, resources and activities. Therefore, to deal with this, we decided to migrate our Moodle instance to the cloud.

[1] Source: https://docs.moodle.org/310/en/History
[2] Source: Official Moodle site, https://stats.moodle.org/
[3] Source: https://moodle.com/news/moodle-in-numbers-during-covid-19/

2 Benefits of cloud services and cloud service providers

Cloud computing is a paradigm that allows on-demand availability of resources such as data storage, computing power, network resources and so on [5]. According to [6] Cloud computing is a model that encompass a subscription-based or pay-per-use paradigm providing services that can be used over the Internet. Large organizations are increasingly using cloud solutions such as Office 365, SalesForce.com, and Google Doc [7].

Many institutions cannot afford the resources needed to implement e-learning systems. This is why the biggest players in the field of e-learning Moodle and Blackboard have now versions of the base applications that are cloud oriented [8]. Cloud based e-learning provisions hardware and software resources to enhance the traditional e-learning infrastructure [9]. According to [10] institutions can significantly reduce the costs for e-learning by using cloud-based solutions.

There are three cloud computing service models: Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). SaaS allows users to connect and use cloud-oriented app over the Internet. Some examples of SaaS are: Google Docs, eCloud Manager, SAP Edition, fluidOps [11]. PaaS is a complete environment in the cloud for development and deployment of applications. Some examples for PaaS are: Google App Engine, EngineYard, AWS Elastic Beanstalk, OpenShift [12]. IaaS enables the use of computing infrastructure over the Internet. Some examples of IaaS are: Azure Virtual Machines, Amazon EC2, AWS S3, Google Compute Engine [13] [14]. We have used the IaaS model for our purposes. IaaS provides the use of cloud-based infrastructure that replaces expensive initial investments in on-premise infrastructure. Maintaining on-premise infrastructure is costly and often requires additional human experts involvement. IaaS solutions provide good vertical and horizontal scalability, all this depending on the needs. With horizontal scaling, new virtual machines are added or existing virtual machines are removed from the pool of resources. Vertical scaling provides the ability to increase or decrease the power (CPU, RAM, Disk space) of existing virtual machines.

Some of the benefits of cloud services are:

- Scalability
- Flexibility
- Work from anywhere
- Cost savings
- Automatic updates
- Disaster Recovery
- Security

Cloud service providers we had in mind were: Microsoft Azure, Amazon Web Services (AWS) and Google Cloud Platform. We used Microsoft Azure for our purposes. Although AWS market share in the worldwide cloud infrastructure is in the first place with 33%, we migrated our Moodle instance to Azure which is in the second place with 18 %[4]. We opted for this platform

[4] Source: https://www.statista.com/chart/18819/worldwide-market-share-of-leading-cloud-infrastructure-service- providers/

because most of the services used at our university are Microsoft services. This facilitated the integration process, especially the user authentication part.

3 Methodology

Figure 1. Flowchart of all activities

The flowchart of all activities is shown in Figure 1. First, we backed up the files from our Moodle instance as well as the database. We used these files and the database backup later in the process of restoring our Moodle instance in Azure. The general architecture and all the services we used from Azure can be seen in Figure 2. We created Virtual Machine Scale Set (VMSS) in Azure. The initial instance in the VMSS is VM with 2 CPU cores, 7GB RAM and Linux Ubuntu 18.04 LTS OS. We transferred the frontend files from our Moodle instance to the initial instance. The good thing about VMSS is that it allows automatic scaling. Next, we created Load Balancer (LB) and connected it to VMSS. LB distributes incoming traffic across instances in the VMSS. This reduces the workload and effectively manages user requests. Using the Azure DB for MySQL Server we created MySQL server (MySQL v.5.7) and restored the database backup from our Moodle instance. This service enables easy database management, scaling, backup and security. The VM of MySQL server has CPU with 4 cores and 20GB RAM. Using the Moodle configuration file, we made a connection to the database. We created a separate Premium SSD disk with a size of 128GB on which we transferred the Moodle files from our Moodle instance. This type of disk provides high availability and scalability. Finally, we attached the disk to the VMSS.

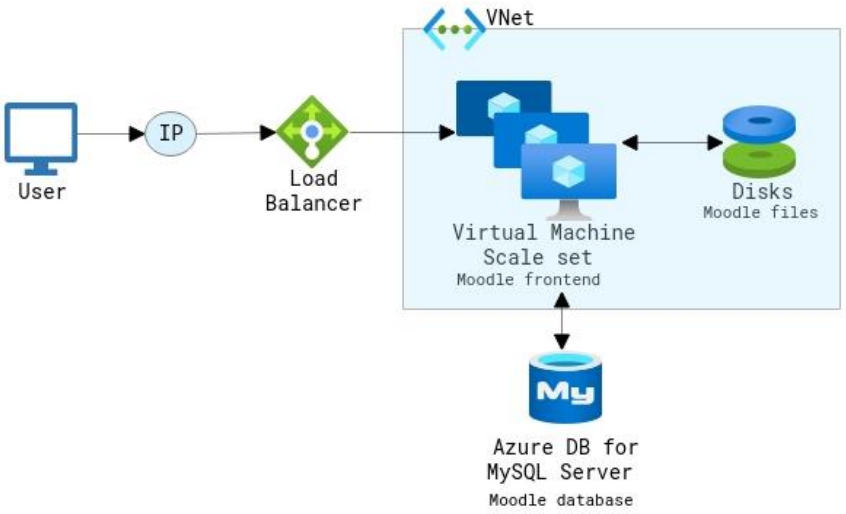


Figure 2. General architecture and used Azure services

In order to avoid high latency and to ensure high availability, it is best all the resources that are created be located in the same Azure region. You can choose the right Azure region according to compliance, data residency, service availability and pricing[5]. For our purposes, we used the West Europe Azure region.

4 Results

The migration of our Moodle instance to Azure has significantly improved its performance. Access to the platform is much faster compared to the instance of the on-premise server. Now we have no problems when a large number of users have electronic testing at the same time. We observed the behavior of the platform during the electronic testing with about 300 concurrent students. The test had 20 multiple choice questions with 1 correct answer. There were 5 questions on each page without the possibility of going back. Testing lasted 20 minutes, with 5 minutes extra time if the students opened the test later. The testing started at 11:05 AM and ended at 11:30 AM. All students completed the test without any problems.

We monitored the usage of resources and here are some of the more important features.

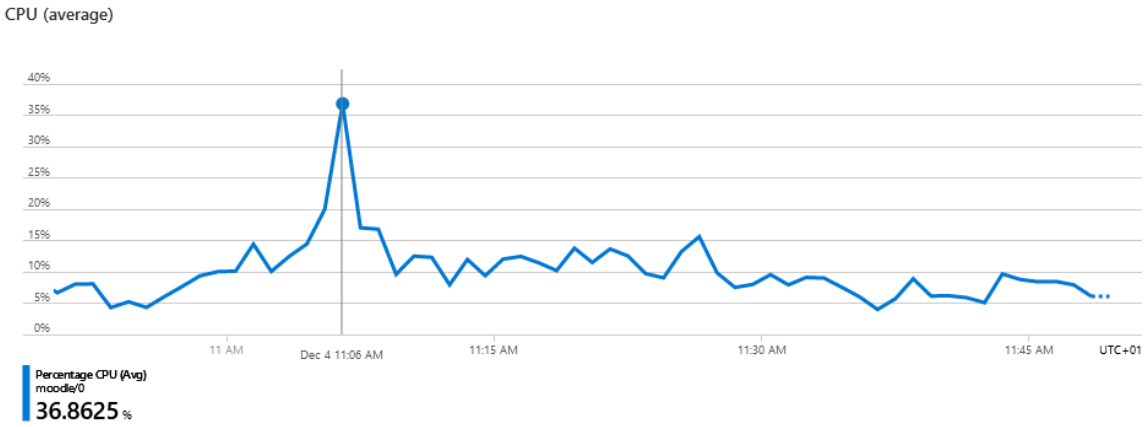
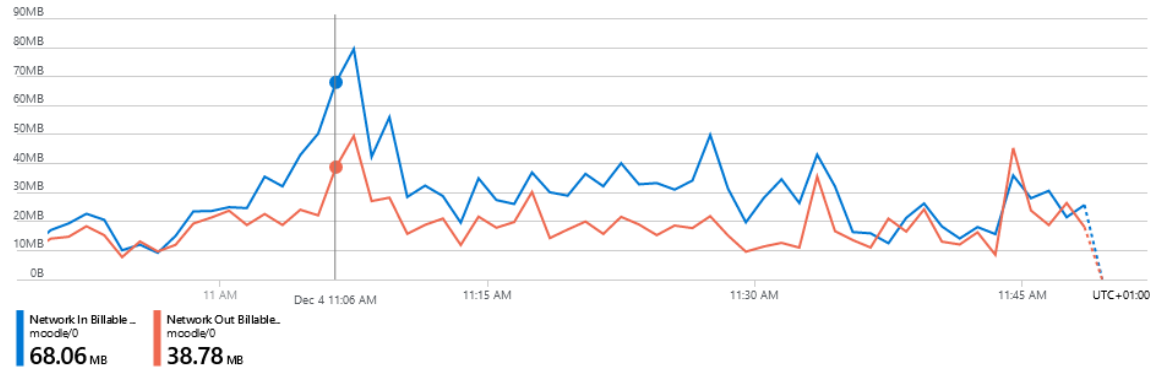


Figure 3. Average CPU usage

In Figure 3, we can see the average CPU usage. The pick is when the students open the test with CPU usage of around 37%. In the rest of the time the CPU usage is below 15%.



[5] Source: https://azure.microsoft.com/en-us/global-infrastructure/geographies/

Figure 4. Outgoing and incoming network traffic

In Figure 4, we can see the total outgoing (Network Out) and the incoming traffic (Network In) of the virtual machine. The peak is after opening the test with value of 80MB for Network In and value of 50MB for Network Out.

In Figure 5, we can see the disk usage during monitoring period. We can see the total amount of bytes read from the disk (Disk Read Bytes) and the total amount of bytes written to disk (Disk Write Bytes). The total sum of Disk Read Bytes is around 61MB while the total sum of Disk Write Bytes is around 156MB. The peak for the Disk Write Bytes is after opening the test with amount of around 6MB while the peak for the Disk Read Bytes is after the end of the test with amount of around 18MB.

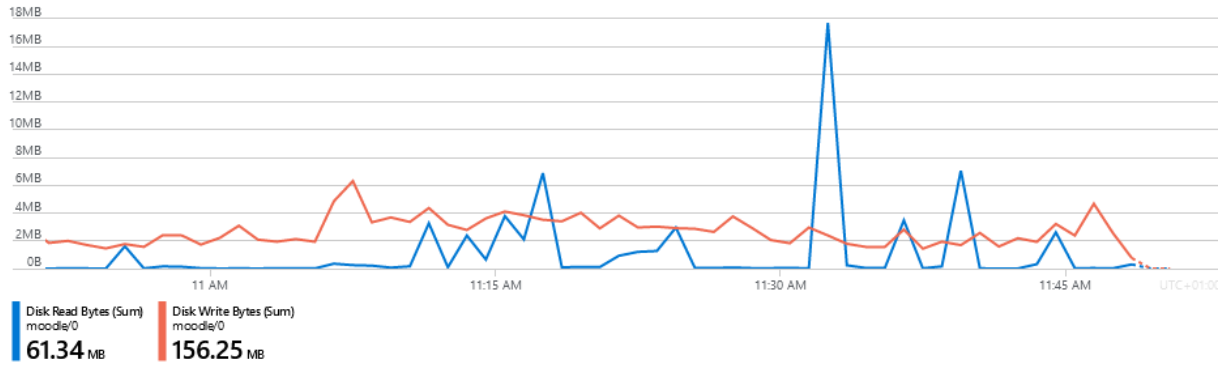


Figure 5. Disk usage during monitoring period

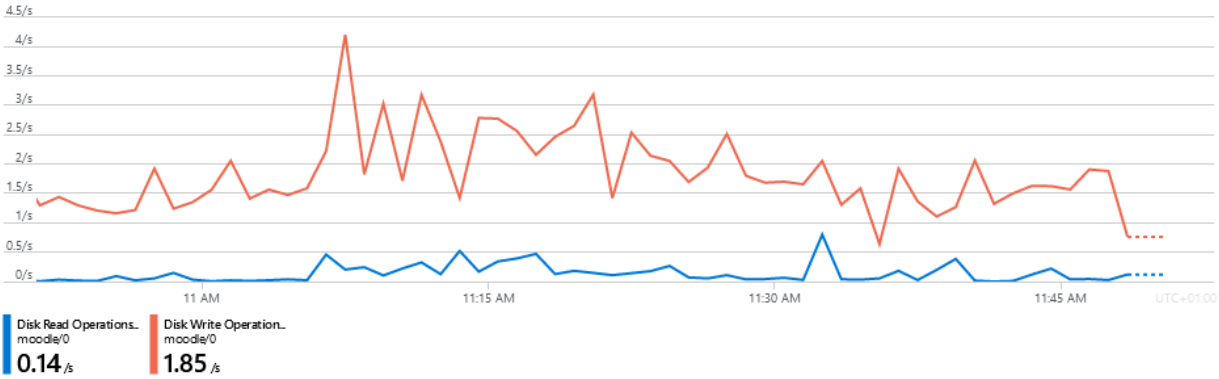


Figure 6. Average disk operations in second

In Figure 6, we can see the average disk operations in second (Disk Read Operations and Disk Write Operations). The peak for Disk Write Operations is after opening the test with value of around 4 operations/s. The peak for Disk Read Operations is after the end of the test with value of around 0.7 operations/s.

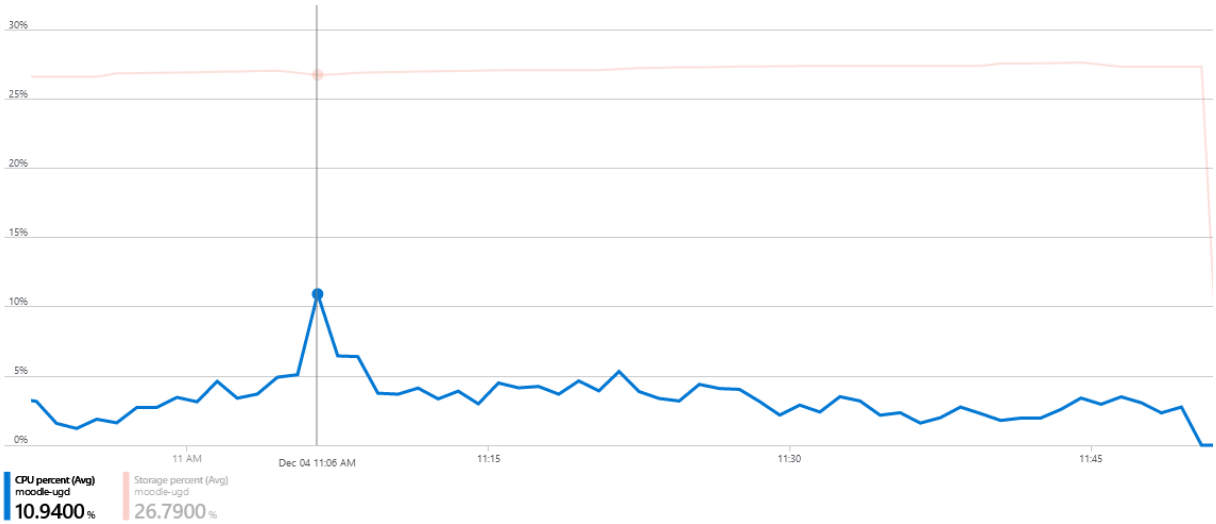


Figure 7. Average CPU usage of MySQL Server

In Figure 7, we can see the average CPU usage of MySQL Server. The peak is also when the students open the test with CPU usage of around 10%. In the rest of the time the CPU usage is below 5%.

The RAM memory usage of the virtual machine is up to 30%.

We can see that resource utilization is low. According to these results for the virtual machine and the MySQL server, we will optimize the performances in order to reduce costs.

5 Conclusion

By migrating to the cloud, we can significantly improve the performance of the Moodle platform. When the number of users is large and we have a lot of user requests we should consider migrating to the cloud. This ensures better scalability, availability and security. The research we made is based on 5 months experience on the cloud. Next, we will try to optimize the usage of resources. In the following period we will be able to say something more about our experience with the cloud.

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