

Original Article

Implementation of a Server Cluster in the Cloud to Optimize Information Management

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Abstract - In this work, the implementation of a cluster of servers in the cloud is carried out to optimize the information management of the company Obuma SPA; this solution aims to optimize the performance of computer applications, provide the scalability of data servers through various elements that make up the proposed topology. The development of this solution will be carried out with the MariaDB database engine, and within the Linux operating system, specifically with the Centos distribution in version 7, which is specifically oriented towards a corporate segment. It is important to know that this implementation greatly benefits the organization because it allows it to offer its services to many more clients since, currently, the company does not invest in advertising for fear that the servers will collapse. For this reason, the need to improve the performance of all its web applications and maintain satisfaction for each of its customers.

Keywords - Applications, Cluster, Computer Science, Performance, Scalability.

1. Introduction

Productivity is a factor that determines the success of organizations in any field; one of the main challenges of the world economy is increasing productivity in each of its sectors and, therefore, of their economies[1]. At the end of the nineties, the European Union had a strong disadvantage in productivity compared to the US. However, it showed a considerable increase in labour productivity in ICT sectors, which allowed it to lead the productivity ranking globally[2]. Currently, the US has an advantage over European countries since they have presented low rates of innovation in their different sectors and have been unable to maintain the advantage they had in previous years[3].

A highly productive company has advantages over others since it is almost always accompanied by a quality service to the client[4][5]. One of them is the commitment to quality of service since it is proven that customers highly perceive the quality of the service offered and the means used to satisfy them [6].

The company OBUMA SPA is a company dedicated to offering online management software to companies throughout Chile; being OBUMA ERP the most prominent product with the highest demand since it offers solutions for electronic invoicing, inventory, electronic stores, management of clients etc. [7].

This company handles a large number of clients, which is why all the applications offered are managed by thousands of users daily; this gives us an idea of the great work developed by the company's workers[8]. Currently, the company OBUMA SPA manages all its applications in a single data server, which had been working well until a few months ago, since at present, the server has been presenting overloads due to the different tasks assigned to it and generates complications with the operation of applications, daily backups, application database processing, company ERP[9], and automated tasks for different systems are the main activities currently running the server. For this reason, the need arises to implement a solution that helps to optimize the activities carried out by the server and thus provide a better service to the company's clients and avoid inconveniences.

The article's objective is to implement a cluster of servers in the cloud to optimize information management in the company OBUMA SPA.

The rest of the document is organized as follows; section 2 will be the literature review, section 3 will define the Scrum methodology and the tools to be used within the project, section 4 will show the case study, in which was visualized the prototypes, section 5 will show the results and discussions; finally, section 6 will show the conclusions.



2. Literature Review

In the research work, a literature review was conducted to evaluate and analyze the work related to cloud server clusters to add to the work made the points that need to be implemented.

The authors [10] emphasize that an intelligent management system such as cloud computing works to improve the shortcomings of the traditional hospital management system. Therefore, the functions of cloud services mention the basic definition by its characteristics. Also, they can link various medical departments and coordinate with all medical institutions, with the improvement of patients and with cloud computing increase the utilization of medical health resources.

On the other hand, the authors[28] designed an intelligent educational platform using cloud technology. The designed platform is developed in a cluster server's environment managed as the center of its data storage by Hadoop. By then, the authors will launch the corresponding services for remote education, as it is an intelligent access that will be used on cell phones and computers as the registration and login of users for learning management.

The authors [12] indicate that cloud computing has become a very important technology, as it can improve IT operations by providing solutions to companies through the Internet. That is why companies have been improving lately because they are working with innovative cloud computing technology—growing their strategic and financial benefits based on emerging technologies by exploring their application in various industries or companies.

In reference, the authors [13] synthesize that Mobile Cloud System is a very important tool currently; its development is fast and important, which provides a way of organization for health through algorithm application. For them, the model provides safety and use as a system for patients; through this patient-centered health system, an effective and easy-to-use human services framework for stroke referral has been implemented.

The authors [14] state that cluster management technology monitors all kinds of events and maintains a complete and constant network state, which often generates big data. The security of clusters is an open issue according to the programmed characteristics and dynamics. Therefore, the authors propose security management based on the analysis of big data to improve the control plane and show the proposed system's efficiency and feasibility.

The authors [15] also define the cloud as a computing paradigm that provides users with adaptable and virtualized resources. Users have access to a pool of shared technology

resources available with minimal user management. Therefore, there are some hurdles and uncertainties when using the cloud. The provision of cloud services is based on services to reach an agreement with the user and service providers. Therefore, if the provider does not meet all the demand requirements that were agreed upon, it is fined. That is why the authors exhaustively reviewed the proposed models and principles of the problem developed in this paper.

According to the authors[16], cloud services continue to play a very important role in the digital transformation of all companies by facilitating flexible ordering of technological resources. Such as Ram, processors, networks and storage. This necessarily involves building and upgrading large systems, including clusters, networks and all the data centers that provide these resources. As a result, all systems consume significant amounts of energy and associated costs, resulting in significant CO.2 emissions.

In the same way, the authors[17] explain that cloud services have gone through many changes from monolithic to weakly connected microservices that reach a complete application. That is why the authors explore the impact of microservices on cloud and server data. They present an end-to-end application built with dozens of microservices from open source. They then use the full service to explore the performance of microservices to highlight their impact on all-data hardware.

The authors [18] emphasize that the increasing use of high-utility cloud services also faces challenges, and it is essential in what can be called consumer goods. The algorithms put forward by the authors are some parameters that they use for the productivity of the main functions can use to estimate all the power consumptions provided. Thus, they present a method called Dynamic Voltage and Frequency Scaling. It is based on all network loads to improve the consumption of technology. This algorithm provides time intervals by monitoring the use of servers by monitoring the use.

Finally, the authors [19] propose an energy-efficient solution for organizing resources in cloud services. The methodology they used was the regression method. They also used convex optimization to calculate a sufficient number of servers. They calculated to guarantee a minimum number of servers. For them to experiment with data from 29 days of google traces and a real work of the open-source tool.

In conclusion, the works are seen to play a very important role since each research work applies different methodologies and different objectives that help to analyze and implement the points that need to be added and improved related to cloud servers.

3. Methodology

The SCRUM methodology was applied in the research work, which is an agile framework consisting of fast deliveries and greater flexibility throughout the project.

3.1. Scrum

3.1.1. Start Stage

In the beginning stage, activities are carried out to obtain the prioritized list of pending products. The activities carried out in this phase are the following[29]:

- Creation of the project vision
- Scrum Team Identification
- Creation of Epics
- Creation of the prioritized Product Backlog
- Make the launch plan

3.1.2. Planning and Estimating

This phase has as its main objectives the estimation of user stories [21]and the Sprint pending list, and the following activities are carried out:

- Create user stories
- User story approval, estimation and assignment
- Task creation
- Task Estimations
- Creation of the Sprint to-do list

This phase is the key to doing good planning and estimating the sprint because it will help to set fixed goals and meet the established deadlines.

3.1.3. Implementation

In this phase, the sprint is discussed, and how to optimize the work within each Scrum group is explored to give a final shape to the project in execution. The activities to be carried out are the following:

- Creation of deliverables
- Hold daily meetings (Daily Scrum)
- Maintaining the prioritized list of the Product Backlog.

3.1.4. Review and Retrospective

When the project is already laid out and implemented, the work team must review the process, which consists of carrying out a self-criticism or internal evaluation of the group regarding the work carried out[22]. The purpose is to obtain constructive criticism and give opinions that favour and help in the improvement of the project. The activities carried out are:

- Demonstration and validation of the sprint
- Sprint Retrospective.

3.1.5. Launching

This phase consists of the outcome of the project and the delivery of the product; the activities carried out are:

- Send deliverables.
- Project Retrospective

All these phases help us to carry out the project in an organized and planned way to obtain a highly elaborated and robust project.

3.2. Development Tools

3.2.1. Centos

The CentOS Project based on free software Linux allows and interacts with the development being carried out in the company [6].

3.2.2. MariaDB

MariaDB is a database that comes from Mysql, and its interaction with users is friendly [23]; nowadays, it is used frequently in organizations.

3.2.3. Galera Cluster

Galera Cluster uses a multimeter replication type in the database replication method. Allows data to be stored on multiple servers and updated from all servers[23].

3.2.4. HaProxy

The load balancer that HA-Proxy uses a series of algorithms that aim to minimize the imbalance between different servers and distribute the load between them in an optimal way[24].

4. Case Study

In this section of the project, the realization of the prototype for the high availability cluster will be explained in detail, which will be elaborated strictly following the identified and defined requirements in order to guarantee its correct elaboration. This entire phase will be carried out following the steps of the previously selected and detailed methodology, the Scrum methodology.

4.1. Start Stage

4.1.1. Identification of Requirements

This section defined the requirements on which the entire project will be based; these requirements were obtained thanks to the meetings held with the company OBUMA SPA. All these aspects are discussed in more detail in Table 1.

4.1.2. User Stories

This section visualizes user stories, that is, requirements expressed in the way a user would. All these aspects are discussed in more detail in Table 2.

4.1.3. Backlog Management

Backlog management is an essential task throughout the project because it can accelerate or slow down activities in a decisive way, see Table 3.

Table 1. Project requirements

1	The server cluster must be implemented With Centos7.
2	Perform initial configurations to all servers.
3	Carry out the DBMS installations and configurations.
4	Configure services for file transfer and encrypted communications.
5	Deploy the cluster for data replication.
6	Configure a Proxy server for load balancing in databases and web applications.
7	Configure an information backup server

Table 2. User stories

1	As a frequent customer of the web applications of the OBUMA company, I would like to use software that is available at all times.
2	As a client of the ERP of the company OBUMASPA, I would like my information to be kept safe in case of any unexpected circumstances.
3	As a client of the company OBUMASPA, I would like to manage a fast system which allows me to carry out my operations as smoothly as possible.
4	As a user of the online store system of the company OBUMA SPA, I would like to be able to access customer information and products without any inconvenience.

Table 3. Backlog Management

No.	Item	Priority	Estimate
1	As a frequent customer of the web applications of the OBUMA company, I would like to use software that is available at all times.	High	6 weeks
2	As a client of the ERP of the company OBUMA SPA, I would like my information to be kept safe in case of any unexpected circumstances.	High	6 weeks
3	As a client of the Company OBUMASPA, I would like to operate a fast system which allows me to carry out my operations as smoothly as possible.	Medium	4 weeks
4	As a user of the online store system of the company OBUMA SPA, I would like to be able to access customer information and products without any inconvenience.	low	2 weeks

4.2. Planning Stage

4.2.1. Estimation with Planning Poker

Planning Poker is a technique for estimating the complexity of users' stories through cards. It is a technique for calculating an estimate based on consensus [21].

All these aspects are discussed in more detail in Table 4, which shows the corresponding estimates for each project sprint. You can display an estimated time for each sprint and a global total of the estimate, which corresponds to the sum of the time of all the sprints.

4.2.2. Sprint Planning

In this part of the planning, the different Sprints will be defined, which will be defined in 4 groups made up of different user stories, with the respective managers of their development, the estimated time in which each sprint will be carried out, and the different acceptance criteria for the different activities carried out in the project[26].

Sprint 1

In this sprint, some activities to be carried out are defined, and the estimated sprint time is 6 weeks; all these aspects are detailed in Table 5.

Table 4. Estimation with planning poker

No	Planning Poker Estimate	Time
1	6	6 weeks
2	6	6 weeks
3	4	4 weeks
4	2	2 weeks
TOTAL	18	18 weeks

Table 5. Planning for Sprint 1

Sprint1	
User history	As a frequent customer of OBUMA company web applications, I would like to use software available at all times.
Responsible	Mauro Enrique Canales Zapata
Item number	1
Estimated time	6 weeks
User	Client
Criteria of acceptance	<ul style="list-style-type: none"> • Configure high-availability tools • Deploy a highly available cluster

Table 6. Sprint 2 planning
Sprint2

User history	As a client of the ERP of the company OBUMASPA, I would like my information to be kept safe in case of any unexpected circumstances.
Responsible	Mauro Enrique Canales Zapata.
Item number	2
Estimated time	6 weeks.
User	Client
Criteria of acceptance.	<ul style="list-style-type: none"> • Server decongestion techniques • Configure and implement load balancing.

Sprint 2

In this sprint, some activities to be carried out are defined, and the estimated time of the sprint is 6 weeks. All these aspects are detailed in Table 6.

Sprint 3

In this sprint, some activities to be carried out are defined, and the estimated time of the sprint is 4 weeks. All these aspects are detailed in Table 7.

Sprint 4

In this sprint, some activities to be carried out are defined, and the estimated time of the sprint is 2 weeks. All these aspects are detailed in Table 8.

Table 7. Planning your Sprint 3
Sprint3

User history	As a client of the company OBUMASPA, I would like to manage a fast system which allows me to carry out my operations as smoothly as possible.
Responsible	Mauro Enrique Canales Zapata
Item number	3
Estimated time	4 weeks
user	Client
Criteria of acceptance	<ul style="list-style-type: none"> • Configure the linkage between the load-balancing server and the MariaDB cluster. • Perform tests for the general operation of the Maria DB cluster, HAPROXY server, and incoming connections.

Table 8. Sprint 4 planning
Sprint4

User history	As a user of the on-line store system of the company OBUMASPA, I would like to be able to access customer information and products without any inconvenience.
Responsible	Mauro Enrique Canales Zapata
Item number	4
Estimated time	2 weeks.
user	Client.
Criteria of acceptance	Plan task segmentation between servers for better performance.

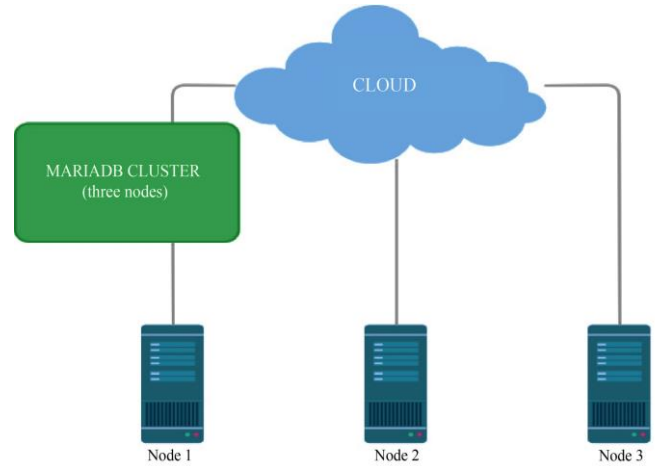


Fig. 1 MariaDB server cluster

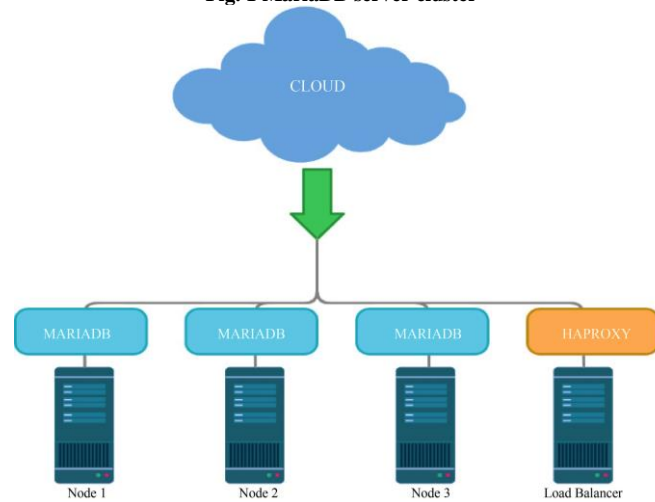


Fig. 2 MariaDB cluster and load balancer

4.3. Development Stage

In this section, the development of the initial prototype of the solution will be carried out, later analyzed, propose improvements to obtain correct feedback.

4.3.1. Initial Prototype

Each project sprint comprises a prototype based on what was planned and described in the previous stages.

Sprint 1 initial prototype

For the development of the prototype of this first sprint, the points specified in Table 5 of the planning corresponding to the sprint were taken into account, as shown in Figure 1.

Sprint 2 Initial Prototype

For the development of the prototype of this first sprint, the points specified in Table 6 of the planning corresponding to the sprint were taken into account, as shown in Figure 2.

Sprint 3 Initial Prototype

For the development of the prototype of this first sprint, the points specified in Table 7 of the planning corresponding to the sprint were taken into account, as shown in Figure 3.

Table 9. Comparison between RUP and SCRUM

Rup Methodology	Scrum Methodology
Comprehensive documentation.	Knowledge is necessary to achieve objectives.
The changes are in phase.	Let us get involved dearly on, and all team members are assigned a role.
It is modeled by use case.	Deliveries on time.
It is closed in architecture guided by risk.	Due to its flexibility, it reduces the cost of change in all stages.
In small projects, the costs dedicated to the necessary equipment of professionals may not be covered.	Visible and transparent throughout the entire work project.

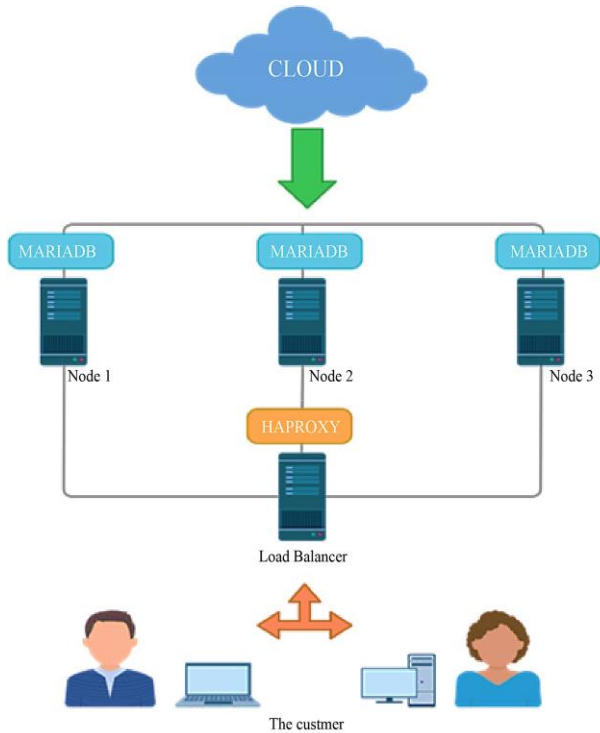


Fig. 3 Full network topology

This image shows the complete prototype of the MariaDB server cluster; you can see how the load balancer works as an intermediary between the client and the different nodes belonging to the MariaDB server cluster. The client makes requests to the databases through the different applications managed by the OBUMASPA company (ERP, WEB applications, online stores, etc.). These requests reach the load-balancing server, which is responsible for redirecting requests to the eligible server and avoiding overloads. It is important to know that the MariaDB server cluster and the load balancer configured with the open-source HaProxy tool work together, as they are technologies that excellently complement each other to obtain much more compact and robust results.

5. Result and Discussions

5.1. About the Case Study

For the case study, the implementation of a cluster of servers in the cloud for information management was carried out in order to ensure that all the applications of the company OBUMA SPA can function properly, without delays and

without loss of service., that is, to achieve a quality system that has a high availability of information in all its applications, something that is being frequently implemented by the largest companies in the world to take their infrastructure and service level to the next level[25] in addition to provide the possibility of being able to be scaled when the company requires it, the proposed solution is much more robust and complete than the current model that has been operating in the organization, it also allows the company to receive more customers since it is designed to support more daily requests from users, something that was previously impossible to achieve[13]. To carry out the design of the prototypes, the Creately tool was used, an online tool that serves to make prototypes of various areas, this time using it to graph and explain the operation and the relationship of the servers involved.

5.2. About the Methodology

The methodology used in this project was SCRUM. The agile methodologies through the scrum framework allow software development to be carried out through deliverables, and this is done through a sprint that lasts between 2 and 4 weeks. In addition, what is planned is monitored by reviewing each sprint and then giving feedback (see Table 9). Each sprint is monitored using the burndown chart. On the other hand, the project is planned from the beginning to the end in the traditional methodology, such as RUP. Results are not requested by stages but by the project itself, analyzing functional and non-functional requirements[22].

6. Conclusion

The prototypes belonging to the implemented solution were developed, which consists of creating a cluster of servers in the cloud to manage the information management in the company OBUMA SPA; for the elaboration of the different prototypes, the Creately tool was used, which is very easy to use in modeling designs. Another important aspect is that the implementation was carried out with the SCRUM methodology, so the project process was very flexible and oriented to teamwork, something that some traditional methodologies do not allow; also, all these points mentioned were important for the implementation since it is a solution that provides better performance, scalability, availability of information and satisfaction for all the company's clients because it provides them with security and gives them the possibility that they can satisfactorily take control of their business.

As future work, I recommend carrying out the project, for example, with a web administration panel that allows you to take the entire cluster and be able to carry out monitoring

and reporting tasks of the current status of each of the clusters; all this thinking about carrying adequate control of a fully secure and complete cluster implementation.

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