Deployment of Secure Collaborative Softwares as a Service in a Private Cloud to a Software Factory

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***Abstract*—This paper presents a proposal of deploying secure communication services in the cloud for software factory university UNB (University of Brasília - Brazil). The deployment of these services will be conducted in a private cloud, allocated in the CESPE (Centro de Seleção e de Promoção de Eventos) servers. The main service that will be available is the EXPRESSO, which is a system maintained by SERPRO (Serviço Federal de Processamento de Dados). These services increase the productivity of the factory members and increase their collaboration in projects developed internally.**

Keywords-software factory; deployment of services; SaaS.

I. INTRODUCTION

The technology of cloud computing aims to provide services on demand, being billed or not by usage, as well as other basic services. Prior trends to cloud computing were limited to a certain class of users or focused on making available a specific demand for IT resources [1]. This technology tends to comply with wide goals, being used not only by big companies that would outsource all its IT services to another company, but also for user who wants to host their personal documents on the Internet. This type of technology allows not only the use of storage resources and processing, but all computer services.

In cloud computing, resources are provided as a service, allowing users to access without knowing the technology used. Thus, the users and companies began to access services on demand, independent of location, which increased the amount of services available [2]. With this, users are moving their data and applications to the cloud and can access them easily from any location.

Cloud computing emerges from the need to build less complex IT infrastructures compared to traditional, where users have to perform installation, configuration and upgrade of software systems, also infrastructure assets are inclined to become obsolete quickly. Therefore, the use of computational platforms of others is a smart solution for users dealing with IT infrastructure.

Cloud computing is a distributed computing model that derives characteristics of grid computing, with regard to the provision of information on demand to multiple concurrent users [2]. A cloud service provider offers cloud applications without the user having to worry about where the services are hosted or how they are offered. Slices of the computational power of the nodes of the network are offered, reducing costs to purvey own infrastructure to provide services. Resources are assigned only during the period of use, reducing power consumption when utilization is no longer needed.

Virtualization technology [6] provides the foundation for many cloud solutions. Moreover, in many solutions environments, where users are able to choose their virtualized resources, such as programming languages, operating system and other custom services are offered. The main benefits are reduction of the costs of infrastructure investment, operating costs and scalability for the provision of services on demand.

Cloud computing is an area that is increasingly growing and attracting diverse audiences. Ever more organizations has adopted cloud computing based solutions.

The objectives of this paper can be summarized by making a study of existing technologies in cloud computing with application to a software factory and contribute for a collaborative environment for software factory.

For a better understanding of this paper is explained now your organization. Section 2 provides a review of the concepts of cloud computing. Section 3 presents a set of possible implementations of solutions for factory software. Section 4 presents an implementation proposal for the software factory. Finally, Section 5 shows some results of this deployment.

II. CLOUD COMPUTING

Cloud computing refers to the use, through the Internet, of diverse applications as if they were installed in the user's computer, independently of platform and location. Several formal definitions for cloud computing have been proposed by industry and academy. We adopt the following definition: "Cloud computing is a model for enabling 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" [3].

Cloud computing is being progressively adopted in different business scenarios in order to obtain flexible and reliable computing environments, with several supporting solutions available in the market. Being based on diverse technologies (e.g., virtualization, utility computing, grid computing, and service-oriented architectures) and constituting a completely new computational paradigm, cloud computing requires high-level management routines. Such management activities include: (a) service provider selection, (b) virtualization technology selection, (c) virtual resources allocation, and (d) monitoring and auditing in order to guarantee Service Level Agreements (SLA)

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A solution of cloud computing is composed of several elements, as shown in Figure 1. These elements form the three parts of a solution cloud [6]. Each element has a purpose and has a specific role in delivering a working application based on cloud.

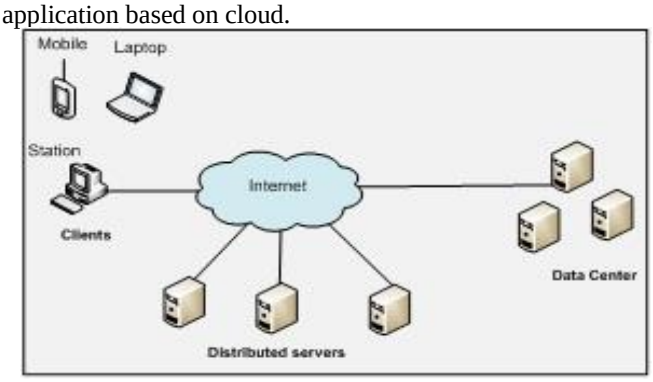

Figure 1. Three Elements of Cloud Computing Solution [6].

- Customers are in a cloud computing architecture, exactly what they are in a simple network. Are the devices with which end users interact to manage your information in the cloud.
- DataCenter is a set of servers where the application (Customer Relationship Management (CRM), financial, etc.) is stored. A growing trend in the IT is virtualization of servers, for example, the software can be installed allowing multiple virtual servers are used.
- Distributed servers: the servers do not have to be allocated in one location. Typically, servers are in different geographic locations, allowing the service provider more flexibility in options and security, for example, Amazon has a cloud solution worldwide. If something happens in one place, causing a failure, the service can be accessed through another site.[3]

A. *Cloud Computing Architecture*

Cloud computing architecture is based on layers. Each layer deals with a particular aspect of making application resources available. Basically, there are two main layers, namely, a lower and a higher resource layer. The lower layer comprises the physical infrastructure and is responsible for the virtualization of storage and computational resources. The higher layer provides specific services, such as: software as service, platform as service and infrastructure as service. These layers may have their own management and monitoring system, independent of each other, thus improving flexibility, reuse and scalability. Figure 2 presents the cloud computing architectural layers [4][5].

1) Software as a Service (SaaS): Provides all the functions of a traditional application, but provides access to specific applications through Internet. The SaaS model reduces concerns with application servers, operating systems, storage, application development, etc. Hence, developers may focus on innovation, and not on infrastructure, leading to faster software systems development. SaaS systems reduce costs since no software licenses are required to access the applications. Instead, users access services on demand. Since the software is mostly Web based, SaaS allows better integration among the business units of a given organization or even among different software services. Examples of SaaS include [7] Google Docs and CRM.

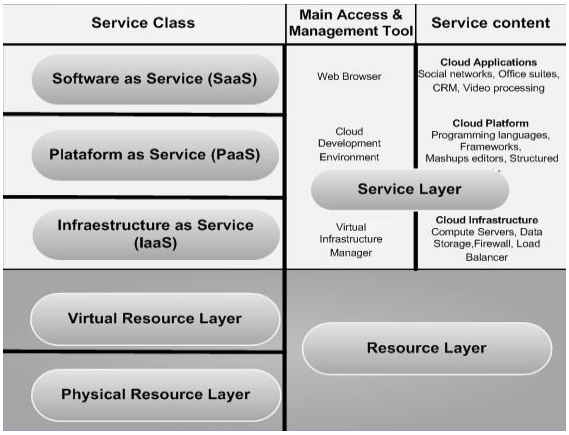

Figure 2. Cloud Computing Architecture [4]

2) Plataform as a Service (PaaS): Is the middle component of the service layer in the cloud. It offers users software and services that do not require downloads or installations. PaaS provides an infrastructure with a high level of integration in order to implement and test cloud applications. The user does not manage the infrastructure (including network, servers, operating systems and storage), but he controls deployed applications and, possibly, their configurations [4]. PaaS provides an operating system, programming languages and application programming environments. Therefore, it enables more efficient software systems implementation, as it includes tools for development and collaboration among developers. From a business standpoint, PaaS allows users to take advantage of third party services, increasing the use of a support model in which users subscribe to IT services or receive problem resolution instructions through the Web. In such scenarios, the work and the responsibilities of company IT teams can be better managed. Examples of SaaS [7] include: Azure Services Platform (Azure), Force.com, EngineYard and Google App Engine.

3) Infrastructure as a Service (IaaS): Is the portion of the architecture responsible for providing the infrastructure necessary for PaaS and SaaS. Its main objective is to make resources such as servers, network and storage more readily accessible by including applications and operating systems. Thus, it offers basic infrastructure on-demand services. IaaS has a unique interface for infrastructure management, an Application Programming Interface (API) for interactions with hosts, switches, and routers, and the capability of adding new equipment in a simple and transparent manner. In general, the user does not manage the underlying

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hardware in the cloud infrastructure, but he controls the operating systems, storage and deployed applications. Eventually, he can also select network components such as firewalls. The term IaaS refers to a computing infrastructure, based on virtualization techniques that can scale dynamically, increasing or reducing resources according to the needs of applications. The main benefit provided by IaaS is the pay-per-use business model [4]. Examples of IaaS [7] include: Amazon Elastic Cloud Computing (EC2) and Elastic Utility Computing Architecture Linking Your Programs To Useful Systems (Eucalyptus).

B. Roles in Cloud Computing

Roles define the responsibilities, access and profile of different users that are part of a cloud computing solution [8]. The provider is responsible for managing, monitoring and guaranteeing the availability of the entire structure of the cloud computing solution. It frees the developer and the final user from such responsibilities, while providing services in the three layers of the architecture. Developers use the resources provided by IaaS and PaaS to provide software services for final users. This multi-role organization helps to define the actors (people who play the roles) in cloud computing environments. Such actors may play several roles at the same time according to need or interest. Only the provider supports all the service layers.

C. Cloud Computing Deployment

According to the intended access methods and availability of cloud computing environments, there are different models of deployment [9]. Access restriction or permission depends on business processes, the type of information and characteristics of the organization. In some organizations, a more restrict environment may be necessary in order to ensure that only properly authorized users can access and use certain resources of the deployed cloud services. A few deployment models for cloud computing are discussed in this section. They include private cloud, public cloud, community cloud, and hybrid cloud.

Private: The cloud infrastructure is exclusively used by a specific organization. The cloud may be local or remote, and managed by the company itself or by a third party. There are policies for accessing cloud services. The techniques employed to enforce such private model may be implemented by means of network management, service provider configuration, authorization and authentication technologies or a combination of these.

Public: The infrastructure is made available to the public at large and can be accessed by any user that knows the service location. In this model, no access restrictions can be applied and no authorization and authentication techniques can be used.

Community: Several organizations may share the cloud services. These services are supported by a specific community with similar interests such as mission, security requirements and policies, or considerations about flexibility. A cloud environment operating according to this model may exist locally or remotely and is normally managed by a commission that represents the community or by a third party.

Hybrid: It involves the composition of two or more clouds. These can be private, community or public clouds which are linked by a proprietary or standard technology that provides portability of data and applications among the composing clouds.

III. POSSIBLE SOLUTIONS FOR DEPLOYMENT

This section aims to investigate what are the possible options available in cloud computing to the university software factory. This chapter is divided by type of architecture, IaaS, PaaS and SaaS for a better understanding.

A. IAAS

IAAS solutions primarily aim to provide virtual machines with all the features of cloud for software factory.

1) Microsoft Windows AZURE: Windows Azure, which was released on February 1, 2010. Is a cloud computing platform and infrastructure, created by Microsoft, for building, deploying and managing applications and services through a global network of Microsoft-managed datacenters. It provides both PaaS and IaaS services and supports many different programming languages, tools and frameworks, including both Microsoft-specific and third party software and systems [11].

OpenStack: OpenStack is an open source software able to manage components of multiple virtualized infrastructures, like the operatinal system manages the components of a computers, OpenStack is called Cloud Operating System, to fulfill the same role in larger scale.

OpenStack is a collection of open source software projects that companies and service providers can use to configure and operate their infrastructure computing and cloud storage. Rackspace and NASA (the U.S. space agency) were the main contributors to the initial project. Rackspace provided a platform "Cloud Files" to implement the storage object OpenStack, while NASA entered the "Nebula" for implementing the computational side.

Eucalyptus: The Eucalyptus project [10] is an open source infrastructure that provides a compatible interface with Amazon EC2, S3, Elastic Block Store (EBS) and allows users to create an infrastructure and experience the cloud computing interface. The Eucalyptus architecture is simple, flexible, modular and contains a hierarchical design which reflects the common features of the environment.

Eucalyptus aims to assist research and development of technologies for cloud computing and has the following features: compatible with EC2, simple installation and deployment management using clusters tools, presents a set of allocation policies interface extensible cloud overlapping functionality that requires no modification on Linux environment, tools for managing and assisting the management of the system and users and the ability to configure multiple clusters, each with private internal network addresses in a single cloud.

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B. PAAS

The PaaS solutions offer a platform for users to simply and quickly put their programs into production, thus providing an environment for quickly testing.

Tsuru: Tsuru is a open source and polyglot platform for cloud computing developed by globo.com since 2012 and it has began to be offered in a preliminary version in 2013 [12]. Like other platforms, the tsuru helps the development of web applications without the any charge of a server environment.

Tsuru uses Juju orchestration of services and takes advantage of the attractive features of its architecture. Supported programming development languages include Go, Java, Python and Ruby.

1) Heroku: Heroku [13] is a platform as a cloud service with support for several programming languages. Heroku was acquired by Salesforce.com in 2010. Heroku is one of the first cloud platformsa and it has been in development since June 2007, when it supported only the Ruby programming language, but since then added support for Java, Node.js, Scala, Python and Perl. The base operating system is Debian or in the latest Ubuntu based on Debian.

C. SAAS

1) Owncloud: The ownCloud is a free and open source web application for data synchronization, file sharing and remote storage of documents written in scripting languages PHP and Java Script. The Owncloud is very similar to the widely used Dropbox, with the primary difference being that ownCloud is free and open-source, thereby giving to anyone the option to install on your own private server, with no limits on storage space (except for hard disk capacity).

2) Expresso: Expresso [14] is a complete communication solution that brings together email, calendar, address book, instant messaging and workflow in a single environment. Because it is a custom version of the E-GroupWare, its development is also based entirely on free software.

IV. PROPOSED DEPLOYMENT

From the studies of cloud computing solutions, a proposal was created based on ease of deployment X relevance X time to deployment. For this paper, two software (SaaS) were chosen to contribute in collaborative software factory. Such software should help to ensure that members of the factory could share project documents, tasks, shared calendars and other tools for project management. An important factor to be considered during the time of adoption of a cloud service is the security. This security issue has attracted several discussions with the Brazilian Federal Government to the extent of having been issued a presidential decree (Decree No. 8.135, of November 4, 2013). The first article of this decree is as follows:

> *"Article 1 - Data communications direct, independent federal government and foundations shall be conducted by telecommunications networks and services of information technology provided by agencies or entities of the federal public administration, including public enterprises and joint stock companies of the Union and its subsidiaries."*

This article clearly shows the concern of the Government, which began to be widely commented after being publicize cases of espionage on the emails of the President of Brazil.

A. IAAS Proposal

The first option selected for the software factory was in IaaS solutions, i.e., to provide a software factory the entire necessary infrastructure in a transparent and scalable way. The software factory does not provide today's servers and storage required to keep, such hardware resources are still going through the bidding process. By aiming to solve this problem, the main solution is that use virtual machines until the factory have their own means of keeping it going. For the provisioning of virtual machines, the XEN Hypervisor [15] was chosen as a solution, because it has a large use in the market besides being open source and have already been studied previously.

Figure 3 shows the installation of two Linux virtual machines on the Windows client. One of the machines is a Linux server and the other one with an Ubuntu GUI.

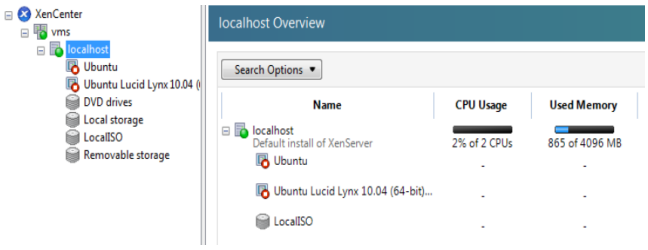

Figure 3. Xen Client.

The interesting aspect that can be seen in the Figure 3 is that we can control independently and completely the memory, the disk and the network; this way, we can have an idea if the VM was well provisioned.

But, in the course of the project, we came across a pleasant surprise; CESPE (Center of Selection and Promotion Events), which is one of the partners of the factory, provides virtual machines using the Windows solution, Microsoft Azure and then making XEN relevant only for research. These machines will be used for the allocation of software offered as a service (SaaS) to the factory.

B. PaaS Proposal

As a software factory, it is very interesting that the factory is able to produce prototypes as quickly as possible, because, as soon as the customer has a prototype, reduces the risks of software that does not add useful features to the client and sooner he will have a preview of the software that will be delivered. It can be very interesting to the factory because it will have a platform where you can quickly put the software into production and can show their customers.

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For this type of service, both OpenShift and Tsuru tools were analyzed, but neither locally, although OpenShift proved to be a powerful tool for such functions. OpenShift supports major language currently used and is a leading solution Open Source.

C. SAAS Proposal

Lastly, we evaluated SaaS solutions and at the first view, these solutions did not prove to be relevant compared to IaaS and PaaS, because the Internet is full of them, such as Dropbox and Google Docs; but, one of the main reasons that lead to not use such software is the security that they do not provide. Because it is a software factory, is extremely important that their projects are not opened at all to other users. It is directly related to the decree mentioned before, SERPRO (Federal Data Processing Service) as the primary IT Company of the federal government, which was designed to provide such services and especially covering the second paragraph.

> "The agencies and entities of the Union referred to header of this article should adopt the email services and its additional features offered by agencies and entities of the federal public administration."

With this scope, Expresso [14] comes in as an email platform and other features that SERPRO is the main developer and it has an internal allocation of its resources, thereby increasing the security of the application.

As previously mentioned, the factory needs solutions that add value to collaborative work. As a solution to this problem, two solutions for SaaS are mentioned:

1) Expresso:

Figure 4. Expresso Log in.

Expresso, as mentioned in the previous section, is one complete communication solution, which includes email, calendar, address book, instant messaging and workflow in a single environment; in Figure 4, the log in of Expresso is shown. This solution greatly facilitates the work of the members of the software factory because they can set up meetings and schedule them on a shared agenda, facilitating the allocation of free time between them. Another very interesting service to be used by the factory is the video call, where project members can have meetings without leaving home, facilitating meetings and expediting meetings, which no longer need to be physically occurred. We can not forget of course the principal Expresso service, which is email, which will be much more secure than allocated in the internet environments, such as Gmail, Hotmail, etc. In Figure 5, the main screen of Expresso is shown.

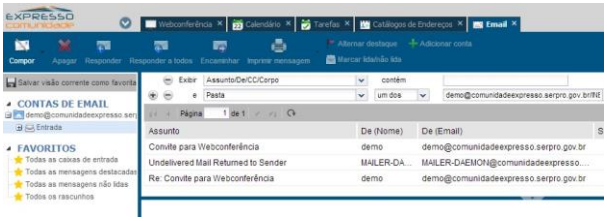

Figure 5. Main Screen of Expresso

Looking at the top of Figure 5, we can see all five tabs that represent the key features of Expresso. First, the selected tab shows the functionality of email with multiple filter options, favorites, etc. Beside the email tab, we have the address book, where all the user's contacts are saved. The next tab shows a very interesting feature that is the task manager where for example a team manager can delegate tasks to any of his members in a simple and fast way. Perhaps, after the email feature, the second most used feature used by the teams is the calendar functionality, because the managers can easily manage the agenda of each of the participants, and facilitate the allocation of meetings, deadlines, etc.

Lastly, we have the functionality of web conferencing, where members of a meeting for example, may join a video conference by simply accepting a request via email, facilitating the occurrence of meetings distributed teams or with difficulty time to face meetings.

2) Owncloud:

Figure 6. Owncloud Log-in

Besides the implementation of the email service, is intended to provide to members of the factory an archive, where it will be possible to share important documents in a safer environment then other solutions, because the files are storage in the factory servers.

The software chosen was the ownCloud, which is a similar solution as the Dropbox; ownCloud is a free open source software and has great community support; in Figure 6, the log in of ownCloud is shown. OwnCloud has as main feature the ability for the users to store their files, so that it can access on any computer with the client, both desktop and smartphones.

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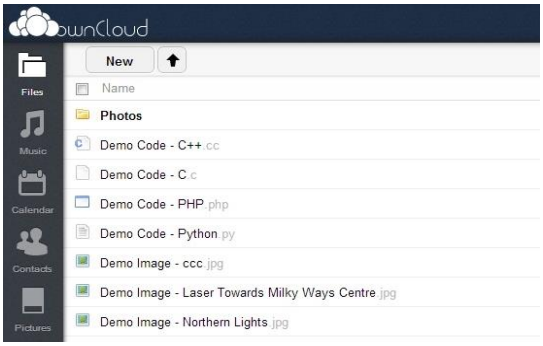

Figure 7. Main Screen of Owncloud

Looking at Figure 7, it is possible to notice the options allocation of ownCloud; the first file is an example of code written in C ++. This type of file can be viewed on its own web interface, already accepted by application and a similar visualization to the IDE for this extension and can it be edited directly from the browser, thus making it easier for programmers in the factory. The same applies for all other languages shown in Figure 7 and also to txt files, printing, and others. By clicking on the images, a pop-up appears with the selected image, facilitating the visualization of it. Lastly we have the songs that can be played directly from the internet.

All these files can be downloaded in two ways: First, when passed the mouse over the file you click on download, and the download is done. On the other hand, the second way, that is by downloading the client ownCloud, so you keep all your files updated.

A. *Deployment*

1) *Roles*

The implementation of Expresso and ownCloud in the software factory is a partnership between three institutions SERPRO, UNB and CESPE. The CESPE assumes the role of infrastructure provider, providing virtual machines and the entire necessary hardware infrastructure for deploying SaaS subsequently this work will be assuming the role of supplier of service provider, providing Expresso to the factory and its customers. This interaction can be best represented by Figure 8.

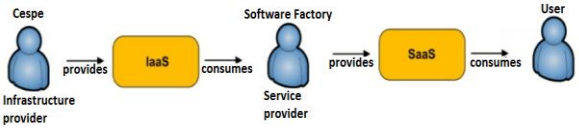

Figure 8. Roles in cloud computing in this context

2) *Process*

The deployment of services is a process that will take all the time devoted to a future work. Figure 9 proposes an initial process that can be appropriately adjusted within the first stage of this process.

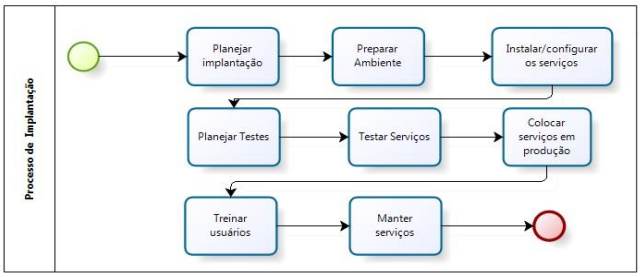

Figure 9. Process of deployment

a) Implementation Plan

This will be the beginning of the process for the services implementation; this phase is intended to study more "low level" of that material (storage, servers) and will be needed for deployment. In this case, we need a better study of the Expresso and the ownCloud to clarify what are the elements that need to be installed and configured.

b) Prepare Environment

At this stage, we already have a good overview of the elements necessary for the installation of the Expresso and the ownCloud. CESPE will help during this phase preparing and configuring all virtual machines.

c) Install services

This phase is intended to install/configure two services presented; this phase is perhaps one of the most time-consuming. Since there is not yet a broad understanding of the process of the installation of services, always unexpected can occur and end up taking a long time. In the case of Expresso, we have a greater ease, since they can have SEPRO aid.

d) Test Plan

After the services are already installed, it is planned to test the software; one can create a document specifying at this stage all the tests that will be performed, as well as expected results and comparing them with the results in the next stage.

e) Test services

After services are fully installed, you must run the tests planned in the previous step for problems that may have occurred in the installation, as a wrong connection with database, causing when people try to login or save your files. In this case you should review if the database has been properly installed and configured, and test again until all tests of test plan are completed

f) Putting services into production

This phase along with the installation is perhaps the most difficult and time consuming. This is because one must ensure that the services are running correctly, and ensure that clients are using them. It should always be close to customers looking to receive feedback on potential improvements and problems.

g) Users training

Right after the services have been put into production, users need a little coaching on how to use the tools. Since

users are mostly students of software engineering, this phase will be very short and easy. However, as the services needed for future maintenance is also included in this phase the transfer of knowledge for any member of the factory, so it can continue the operation of the service. At this stage, we will have the help of SERPRO also, which may give workshops on the operation of the Expresso, thus arousing the interest of members of the factory proposing future functionalities for the tool.

h) Maintenance Services

As most software evolves and presents problems, there is always the need for continued maintenance and upgrades thereof. The members walked in the previous training will first take the maintenance services.

V. DEPLOYMENT RESULTS

After having defined the Express and the ownCloud as software as services to be deployed, it moved to the implementation step. Firstly CESPE released 3 virtual machines with Debian 7 operating system and Intel Xeon x5660 2.8 GHZ 4 cores and 4GB memory, two machines with 100GB HD and the third one with 1TB . In the first virtual machine was installed the Express, in the second one the OwnCloud in the third one the Postgres database, this organization can be seen in Figure 10. Today, 2 months after the installation, Expresso proved to be a powerful communication suite and the OwnCloud surprises by its functionality and interface very similar to the already known Dropbox. We opted for a centralized database for both applications, thereby centralizing all information; thus, it is safer to keep the data because you can restrict the access to this virtual machine, for example by closing all ports in the firewall, leaving only port 5432 open, hindering unauthorized access.

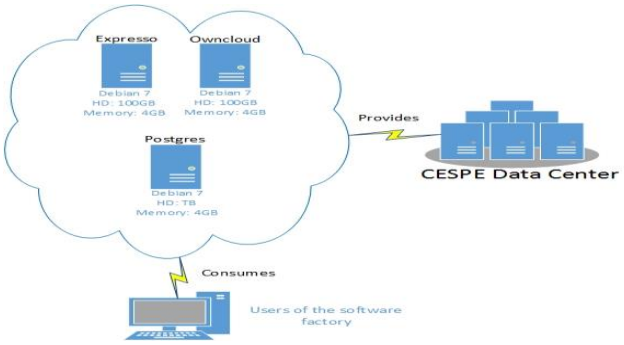

Figure 10. Physical architecture

VI. CONCLUSION

With each passing day cloud computing has been present in our lives, not only for personal use, but also increasingly in professional use. As much as cloud computing brings many benefits, it also brings many challenges. One of the major challenges is in relation to data security, especially after the scandals in Brazil and in the world in relation to privacy.

This paper provided an overview of tools that implement the three main types of cloud architecture; additioanlly, a proposal for the implementation of two of the tools analyzed, one ownCloud, which deploys a system of file sharing, and Expresso as email service.

Using these services is expected that the collaborative development of the factory becomes more facilitated and reliable with the exchange of files and emails, which will be more secure than allocated in the internet environments, such as Gmail and Dropbox.

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