IP Telephony Applicability in Cloud Computing
Aplicabilidad de telefonía IP en la computación en la nube

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Abstract—**This paper carries out a research related to the applicability of VoIP over Cloud Computing to guarantee service stability and elasticity of the organizations. In this paper, Elastix is used as an open source software that allows the management and control of a Private Branch Exchange (PBX); and for developing, it is used the services given Amazon Web Services due to their leadership and experience in cloud computing providing security, scalability, backup service and feasibility for the users.**

Keywords—**VoIP, Cloud Computing, Elastix, Amazon Web Service.**

Resume—**Este trabajo lleva a cabo una investigación relacionada con la aplicabilidad de VoIP sobre Cloud Computing para garantizar la estabilidad del servicio y la elasticidad de las organizaciones. En este documento, Elastix se utiliza como un software de código abierto que permite gestión y control de una central telefónica privada (PBX); y para el desarrollo, se utilizan los servicios prestados a Amazon Web Services debido a su liderazgo y experiencia en computación en la nube que brinda seguridad, escalabilidad y servicio de respaldo y viabilidad para los usuarios.**

Palabras Clave—**VoIP, Cloud Computing, Elastix, Amazon Web Service.**

INTRODUCTION

Through the years, all the organizations around the world try to optimize financial resources related to technology. The time comes and newer and better solutions appear to cover organizational and final user needs. When there was no internet and thus traditional communications were made through phone calls using analog signal switched circuits on a PSTN (Public Switched Telephone Network), ARPANET will perform an experimental network voice Protocol, with the development of standards and protocols for this service (Lamarca, 2013).

The internet has become an essential resource for any company; since it allows to reduce resources and offers better services to customers. We are currently living in constant changes around the world, one of them is the way we communicate. Communications have experienced huge changes over the past one hundred years (Martinez Jacobso, 2017). Via networks no matter where you are, whenever you have access to the internet, you will be online.

The technological trend that is making in the field of telephony with the use of the internet as the platform of the service is the voice over IP (VoIP) in cloud computing. According to Telephony ip, they indicate that "voice over Internet Protocol, also called voice over IP, voice over IP, VoIP, VoIP (for its acronym in English, Voice over IP), is a group of resources that makes the voice signal travel over the Internet using an IP (Internet Protocol) Protocol". This means that the voice signal sends in digital form, using data packets, instead of sending it in analog form via circuits usable only by conventional telephony networks PSTN.ÍP telephony through the cloud aims to be a complete service which allows corporate communications, that contains compatibility of the applications that can be voice, instant messaging, video conferencing, email web applications for pc among others (Ruiz et al., 2017).

After the analysis and study of the applicability that has IP telephony in the cloud computing, these it represents a step forward in the automation of the processes of communication, thanks to the benefits of this technology in which you can make calls, instant messaging and emails. As it says "We must have to get in mind that the PBX is a tool that allows maintaining control and improves management by incorporating all in one unified system (fax, email, among others)"(Zambrano Quiroz, 2013).

For a contribution of the raised issue, it makes reference in the use of the tool Elastix as a free software that allows the management and control of the PBX. Implementation of IP-Telephony ensures the stability of the service, the flexibility of the growth of the organizations and considering the adaptability and convergence of the network and the reference of

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the new telephone system that is available 24/7 in active use for communication between clients and business providers.

Further analysis and study were conducted to determine the best company for cloud computing, where it was determined the design of the infrastructure of the cloud, on which it has installed an IP-Elastix Central to ensure safety, also determined the minimum requirements for both, the server and clients (hardware/software) for the implementation of the central IP.

For the implementation of cloud IP telephony, it used accessible resources, as a computer where the telephone set up through management of a configured software with free application called Asterisk Software. The company that provides the clouding solution is Amazon Web Services, which is the leader and the most experienced in cloud computing. With its infrastructure, it offers security, scalability, backup service and feasibility for the users. On the other hand, it was used in applications such as SIP (session home Protocol) in the case of mobile phones and the Softphone tool in PCs for their interaction in the IP telephony environment.

Worth it to mention that previously to the implementation was carried out an analysis and verification of current resources which had the institution, in order to present the best proposal that benefits to the entity for technological improvement.

RELATED WORK

Voice-over-IP (VoIP) System is useful for growing companies, that if they want to add more phone lines they will not have the need for expenditures on wiring installation because with the VoIP service it is not necessary, inasmuch as provides efficiency at the time of using our bandwidth, optimizing network traffic. It reduces the cost of resources and offers the same benefits of traditional telephony.

Currently, it seeks to optimize resources by voice IP services. In the following research work was carried out a guide for the network design for Voice-over IP in cloud computing, where users do not need to own equipment of telephone network switching, but only one connection to the Internet to obtain all the advantages that this entails such as savings in significant investments in equipment and recurring payments to telephone operators and to obtain geographic mobility. In addition to carrying out the respective investigations about whether it was possible to use Web protocols to make voice calls, without the need to install a pre-existing software on the terminal equipment, but to make them through a Web browser, having as a result a model of VoIP in the cloud and the design of a complete architecture provision of VoIP in the cloud for telephony equipment with Web interface.

In another case related to our study subject. According to the objectives that were proposed, it managed a private cloud deployment, to provide VoIP service. Cloud Computing solution was developed and deployed with OpenStack, on Ubuntu Server Operating System. The VoIP server that was raised initially was Elastix, which is based on Asterisk, however, this was not supported by the version of OpenStack, thus being based on Asterisk, they were able to install this one. OpenStack uses a dualization of the network that has internal and external networks and internal instances that manage connections between nodes and the external does not have a connection with clients or networks that do not belong to instances of OpenStack (Cornejo Orellana and Díaz Escalante, 2015).

IP TELEPHONY CLOUD COMPUTING ARCHITECTURE

VoIP is a signaling technology and call processing in real time, (Cueva and Mario, 2010) through IP networks for voice communication, this technology is led by some standardization organizations as IETF17y la UIT18 in order to achieve the convergence of technologies for IP communications.

VoIP has basic elements such as Servers used for communication, Customers who make use of the services, and Equipment such as transmitters and receivers and all the hardware involved in the communication (Cueva and Mario, 2010), which makes the signal conversion from analog to digital through sampling, quantitation, and coding (Baque Pinargote, 2008). The detailed layers with the respective protocols involved in the communication of IP telephony are shown in Figure 1. This structure is related to the OSI model, except the stealthy involved in the Application and Transport layers. In Application layer, there are specific voice protocols such as SIP, H.323 e IAX. Related to Transport layer the protocol used is RTP, which is a Real Time Protocol used for video conferences, i.e., voice and video within the VoIP traffic.
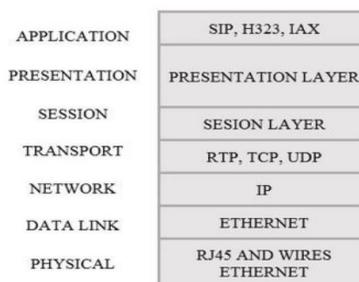

Figure 1. VoIP reference model.
Source: Prepared by the authors.

Protocols used in VoIP

The main protocols used in VoIP are H.323 and SIP at the Application Layer, and they are used to establish the call. RTP instead is responsible for managing the transport of call, and IAX for its part is the only protocol that handles both transport and the call session. Some protocols used by VoIP for packages transfer are explained in the following paragraphs, as well as its specific characteristics related their function within the voice network, which is similar to the TCP/IP network.

Signaling Protocols

Signaling protocols are responsible for establishment, cancellation, and handling of the calls. According to the standard used, there will be an explanation about the most widely used VoIP protocols (Saavedra López, 2011).

SIP is an Application Layer protocol used for IETF logon and serves to establish sessions for calls and videos in real time. SIP is much simpler than H.323 protocol, due to the fact that H.323 has additional protocols for calls control, making it more secure communications, but complicating its implementation. SIP uses proxy servers to route requests, authenticate and authorize services, and can travel through any Transport Protocol. Following the main functions (Baque Pinargote, 2008):

- Identify the host for the connection.
- Analyze if call receiver is available.
- Establishes the exchange of data during the call.
- Establishes the session between the caller and call receiver.

A SIP is basically composed of the following main elements:

- User-agent: the user that makes or receives calls.
- Server: Responsible for establishing and maintaining calls.

VOICE TRANSPORT PROTOCOLS

They are responsible for the transmission of digitized voice packets, from one place to another, through voice flows, and then they can be reconstructed in the correct order. RTP (Real Time Protocol), which is designed for real-time packet transport, as in the case of the voice that is also used for this purpose. RTP encapsulated UDP for transmission since it offers a fast delivery (Cornejo Orellana and Díaz Escalante, 2015).

IP Telephones

Basically, an IP phone is usually a hardware device with telephone shape, but with the difference that uses a network connection of data, instead of a telephone network connection. Therefore, a basic IP phone will have at least one network interface that supports the IP Protocol and at least one VoIP protocol (Sierra Rodríguez et al., 2008).

Elastix Server

Elastix is a code for the establishment of unified communications software. Thinking of this concept the aim of Elastix is to incorporate in a single solution all media and communication alternatives in the business field Elastix has multiple features and functionalities related to services provided by IP telephony, email server, Fax Server, conferences, instant messaging, among others. We have new features, functionalities, and services offered by Elastix according to Techno Sys solutions.

PBX: Support for follow - me, Hardware detection interface, support for groups of ring detection, DHCP server for dynamic allocation of IPs among others.

Fax: Fax Server based on HylaFax, Integrated fax viewer with downloadable PDFs, fax-to-email application, module SendFax - Fax sending through the Web interface.

General: Backups to an FTP server, Heartbeat module, module client DHCP, Backup and auto-Restore list.

Instant messaging: Instant Messaging server based on OpenFire, report of sessions from users, home of calls from Messenger, Porte Jabber client.

Email: Email Server with multi-domain support, support for quotas, via the Web, Antispam support centralized management.

VoIP applications (softphone)

A Softphone (an English combination of Software and Telephone) is a software that makes a conventional telephone simulation by computer. I.e. allows using the computer to make calls to others softphones, IP phones or another conventional phone. Normally, a Softphone is part of a voice-over-IP environment since its installation is limited to install a program on your computer, there are many Softphones for any of the most popular operating systems. The softphones usually contain all the features that the IP phones have, some are improved, for example, phone agendas by not having the limitations talking about the memory that can have a device. The softphones need additional hardware to operate on a PC, because at least they need a microphone and speaker, although in some portable computers are already integrated. Some softphones support connecting a low-cost USB phone.

Some of the most popular Softphones are - eyeBeam of CounterPath (formerly Xten) and Xphone, Zoiper, SJphone. Among those previously mentioned, we have selected, for its use, the Zoiper Free softphone, for three main reasons (Sierra Rodríguez et al., 2008):

- It is free, distributed under Freeware license.
- It supports SIP and IAX2 protocols.
- This primarily developed for Windows environments.
- It supports all the basic functionality we need.

Cloud Computing Architecture

The cloud computing architecture consists of a collection of servers that are usually accessible via internet (Miller, 2008). Therefore users connect to the cloud through their personal computers or handheld devices. For users, the cloud is seen as a particular application, device, or a document, therefore the hardware for them is invisible. Architecture in the cloud has an interface to the user, where you select a task or service. The request of the user goes to the system management, which finds the correct resources and then calls the adequate provisions-maintenance system. These services look for resources in the cloud, and then creates or opens the service requested from servers in the cloud, therefore in a structural sense, cloud computing solution consists of several elements: clients, data center, and distributed servers.

The typical scenario of a company is that clients are users of cloud computing, to connect elements usually found in a LAN. They are typically desktop computers, laptops, tablets, smart mobile phones. The data center is a collection of servers, hosting the applications to which the user subscribes. One aspect to consider is that there is a growing trend in the IT world to server virtualization (Miller, 2008), that means that the software can be installed, allowing multiple instances of

servers to be used. In this way, you can have some virtual servers running on a single physical server.

The distributed servers are born from the idea that not all servers are in the same venue, but dispersed geographically. But to the user, it is as if they all were together, which creates a big advantage, especially for forecasting disaster which allows services being always operating. Cloud computing architecture consists of a set of layers that are coupled together to provide the functionality of the system.

Physical resources layer: They include items such as servers, storage, and network.

Virtualization layer: includes virtual infrastructure as a service.

Infrastructure layer: includes software platform as a service.

Platform layer: includes components of Application as a service.

Application Layer: includes web-based services and software as a service (Kezherashvili, 2010).

Public cloud providers

Below are some service providers who are setting the trend in the market today. The supplier of reference in IaaS (Amazon Web Services), and the reference in services PaaS (Microsoft Windows Azure) has been described.

Amazon Web Services (AWS)

One of the most outstanding IaaS market providers is Amazon Web Services. This provider allows its users to create a virtual machine image from Amazon (MAI), that is, a virtual machine with the operating system Windows o Linux, in which the users install their applications, libraries, and data you need. Later, Amazon runs that machine on their systems, and assigned physical characteristics (such as the capacity of maximum available processing, the amount of maximum used memory RAM space available maximum storage, etc.) according to the contract signed with the user. The user accesses to that machine remotely in the same way that would access a traditional physical server. Also, the user can tell Amazon to expand their systems automatically according to the conditions that have been established previously and can monitor or control the State of your virtual machine at any moment. It follows on directly from Amazon public cloud (Figure 2).

Enterprise / Description	Amazon
Birth of the service	2002
Coste	The cost to register is for the first time will be free for one year but using 750 hours per month and also, will depend on the use of the tools they use and the bandwidth and after the small server price: $41.30 medium server price: $142
Backup	You can be 3 copies within the same geographical area, and also allows you to replicate it in other areas.
Availability	You can provide availability of 99.95% since working in 35 areas and 13 regions.
Support	The stand has a cost of $400 per month 24/7.
System Operative	Windows Server, Microsoft SQL Server, Red Hat Enterprise, Linux, Oracle Enterprise Linux, Java Application Server, etc.

Figure 2. Amazon Cloud provider.
Source: Prepared by the authors.

The most outstanding services from Amazon are EC2 and S3. Then describe the main characteristics of each of them (Arévalo, 2011).

Amazon Elastic Compute Cloud (EC2)

Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides-editable size with computing capacity in the cloud. It has been designed in order to make web computing easier for developers (Murty, 2008). The easy-to-use interface of Amazon web services EC2 allows you to get and set up capacity with minimal friction. Provides complete control over your re-computing courses and allowed to run on the Amazon accredited computing environment. Amazon EC2 reduces the time to get and start new server instances in a matter of minutes, allowing you to quickly scale their capacity (increase or reduce it) when you change the computing requirements (Murty, 2008).

Amazon Simple Storage Service (S3)

Another classic Amazon server is S3. Amazon S3 is in the cloud storage service. It is designed to make the large-scale web computing easier. Amazon S3 provides a simple web services interface that can be used-agencies to store and retrieve any amount of data, at any time, from anywhere on the web. It allows any developer accesses to the infrastructure that is highly scalable, reliable, secure, and fast, that Amazon uses to run its own global network of websites. The service aims to maximize the benefits of scale and to pass those benefits to the developers. Amazon S3 is intentionally created with a set of minimal functions.

Microsoft Windows Azure

An of the most prominent suppliers at the moment is Windows Azure, which offers the creation of Web applications tailored to their systems and their deployment with certain limitations of consumption. Supports multiple programming languages and allows you to share applications with all the world or just with whoever you want. Also, you can start to use for free and only pay if you need to increase the limits or the resources used later, at a lower cost than traditional systems (Arévalo, 2011).

The details on the Amazon public cloud provider are shown in Figure 3.

IP Telephony Cloud Provider

After having the main characteristics of the cloud providers decided to choose Amazon EC2, because presents an authentic virtual computing environment, which allows you to use web service interfaces to start instances with different operating systems, load them with your custom application environment, manage their network access permissions and run your image using the systems that you want to. To use Amazon EC2, you only need to: Select a template image pre-configured to pass to be active immediately. Or create an Amazon Machine Image (AMI) that contains your applications, libraries, data and associated configuration values. Configure security and

Enterprise / Description	Microsoft Azure
Birth of the service	2009
Coste	Payments are carried out by minutes. Small server price: $45,53 median server price: $191
Backup	Similarly, it makes 3 copies within the same area and also let's replicate them
Availability	Ensuring the connectivity of 99.95% of its instances.
Support	It has a free support using knowledge base. Contact by web 24 x 7. 8-hour response time. $ 25.90/month call 24 x 7. 2 hour response time. $271 / I.
System Operative	Windows server R2 2012, Linux, Oracle, SQL Server, post-Linux, among others.

Figure 3. Microsoft Azure cloud provider.

Source: Prepared by the authors.

network access on your instance of Amazon EC2. Select the types of instances and operating systems that you want, and then initiate, finish and monitor as many instances of their AMI as necessary, through the web service API or the variety of management tools provided.

The features offered by Amazon with this service are:

Pad - Amazon EC2 allows you to increase or decrease the capacity in a matter of minutes, without waiting for hours or days. You can send a hundreds or even thousands of ins-circumstances of the server at the same time. Given that everything is controlled by the web service API, your application can be scaled automatically according to your needs increase or reduction.

Total control - Pad - Amazon EC2 allows you to increase or decrease the capacity in a matter of minutes, without waiting for hours or days. You can send a hundreds or even thousands of ins-circumstances of the server at the same time. Given that everything is controlled by the web service API, your application can be scaled automatically according to your needs increase or reduction.

Flexibility - You have the option of several types of instances, operating systems and software packages. Amazon EC2 allows you to select a configuration of memory, CPU, storage of instances and the size of the petition optimum start for your operating system and its implementation. For example, your choices of operating systems include several distributions of Linux, Microsoft Windows Server and Open Solaris. With a design intended for its use with other Amazon Web Services - Amazon EC2 works with Amazon Simple Storage Service (Amazon S3), Amazon's Simple DB and Amazon Simple Queue Service (Amazon SQS) to provide a complete solution, query processing, and storage in a wide range of applications.

Reliable - Amazon EC2 provides a highly reliable environment where replacement instances can be sent quickly and advance. The service runs on data centers and an accredited network of Amazon infrastructure. The commitment of Amazon EC2 service-level agreement 99.95 % availability in each Region of Amazon EC2 is [19].

Insurance - Amazon EC2 provides various mechanisms to protect computing resources.

Amazon EC2 includes web service interfaces to configure the firewall that controls the network access to groups of instances and access between these.

EVALUATION AND RESULTS

Functional Architecture

In Figure 4, it shows our case study where it was selected as server provider from the cloud to the company Amazon Web Service installed in the Elastix IP(central), the same that connects to the local network to use the VOIP system in the cloud. This technology has the advantage that operations that are performed throughout the network are more secure and robust through a single platform voice and data services.
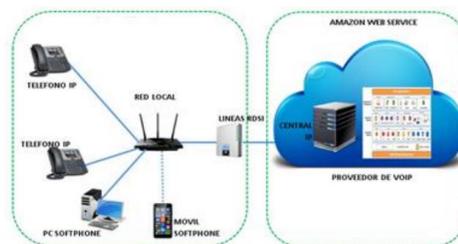
Figure 4. Architecture on the functioning of the IP telephony in the cloud.

Source: Prepared by the authors.

For the implementation of the IP telephony in the cloud, it should perform procedures such as the creation, registration, installation, and configuration.

Configuration of OPENFIRE IM

Instant Messaging for the configuration of Open fire IM a database is created and a user for the service .ºPENFIRE". Connected the instance of AmazonEC2, you create the database in MySQL, creating the admin user to the database. It is appropriated to ins-cut Open Fire from the main menu web environment. Finally, you create new users by entering the management console Open Fire and filling out the appropriate fields.

Video call settings

Direct access to the FreePBX environment is enabled and the video call is enabled, subsequently, the configuration is done for remote clients.

Client configuration

Once is installed Zoiper, the clients can configure, by selecting the "SIP" account type, then it must have to set up the host, username and password for later create the account "SIP"to open Zoiper. The carried-out process for a test video call was done from 101 "PC" extension to a 102 "cellular", as it is shown in figure 5.

User access to the Elastix web environment and e-mail address

The IP address with the username and password provided by the administrator. When the user wants to enter the e-mail "Webmail"will appear a pan-size of authentication in which you must enter their credentials .ᵉ-mail.ᵃnd "key.
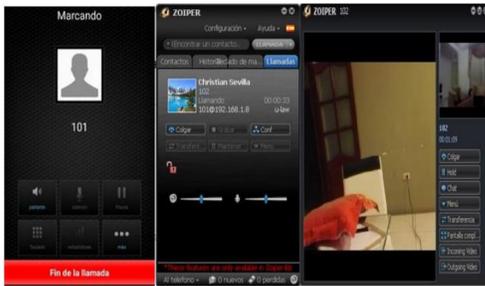
Figure 5. Call test / successful video call.

Source: Prepared by the authors.

IM client configuration (Openfire)

For the configuration of the clients for instant messaging is used Chateau-re that allows users to send instant messages and chats using a cellular phone.

CONCLUSIONS

The Cloud focuses on generating value and innovation. It increases the productivity and therefore the competitiveness of the companies since it increases the availability of the computer services. It accelerates the start-up of new applications and services (time to market), so Amazon EC2 easily and simply integrates the IP telephony service.

This way there is no need for large investments in hardware and software. Its installation and configuration using Elastix, a free software that allows the Administration and control of a PBX, allowed unified communications establishment and subsequently the implementation of IP telephony in the cloud, which offers a simple method of server access, storage, databases and a wide range of applications through Internet services.

VoIP is a protocol which converts the voice into data packets, which are transmitted, as any other content, in an enterprise network. But IP telephony goes much further, because the Voice-over-IP offers communications services business, with all the functions of a PBX and other advanced functions as Simplification of Management, Messaging, Remote Extensions.

IP telephony does not work connected to a traditional voice line, but only on an IP network, so it can receive and sends both calls, such as instant messaging, e-mail, voice mail.

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