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"DESIGN AND IMPLEMENTATION OF THE SYSTEM OF TELEPHONY IP BASED ON ASTERISK ON THE PROTOCOL IPv6 FOR THE INTERCOMMUNICATION IN THE DEPENDENCES OF THE COMPANY SINFOTECNIA"

PROJECT FORESAW TO THE OBTAINING OF THE ENGINEER'S TITLE IN ELECTRONICS AND NETWORKS OF COMMUNICATION

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"DESIGN AND IMPLEMENTATION OF THE SYSTEM OF TELEPHONY IP BASED ON ASTERISK ON THE PROTOCOL IPv6 FOR THE INTERCOMMUNICATION IN THE DEPENDENCES OF THE COMPANY SINFOTECNIA"

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Summary: The present project consists of the design and implementation of a system of telephony IP based on Asterisk on the protocol IPv6 for the intercommunication of the dependences of the company Sinfotecnia with the aim to improve the current system of communication that the company has for the internal and external communication between his employees and his clients

I. Introduction

At present the systems of telephony IP have turned into a basic tool for the great majority of organizations, companies and institutions thanks to the flexibility, scalability and operability that offers in the communications beside being of benefit in different areas as: economic, optimization and technological. Inside the systems of telephony IP there exist several devices used for the communication as the telephones IP, Softphones, Gateway or cards of telephony with interfaces FOX/FXS, etc. These devices form an essential part in the systems of telephony IP since they allow the communication between the networks IP and the PSTN.

Due to the deficiencies and limitations that nowadays there presents the Internet protocol IPv4, it considers to work, on the new version of the Internet protocol IPv6. The same one that offers: efficiency, scalability, extensibidad, mobility, safety, major space of addressing, mechanism of transition, etc. Besides the fact that the coexistence allows of new protocol of communication with the protocols of his predecessor IPv4.

The design and the implementation of the system of telephony IP on the protocol IPv6, he will be of benefit to the personnel to the personnel of the company Sinfotecnia due to the fact that it will allow to have a service of telephonic efficient and constant communication at all time between the internal departments of each one of the dependences of the company and between his clients, in addition the users were enjoying more applications as those who offer other systems real time IP-PBX, beside possessing also the possibility of realizing a future growth.

II. IP Telephony

The telephony IP is a totally organized technology due to the fact that it allows to control all the communications of the VoIP and has the aptitude to integrate the services that there offers a traditional PBX as well as the configuration of new applications and of this form to allow that the companies should have safety benefits, flexibility and scalability in the network of information. [1]

This technology can incorporate some functions as the analogous digital conversion, protocols of signposting and transport, plan of bearing, etc. In addition it can use different devices for the telephonic communication as Hardphones, Softphones, analogous or digital Gateways.

A. Advantages of the telephony IP

- Effective communication between users of different places to a low cost.
- Integrated Traffic of voice and information on an alone infrastructure

of network, simplifying the management and reducing the costs.

- Utilization of the telephonic system of agreement to his needs and requirements.
- Interconnection with other networks (PSTN, Mobile Operators).
- Integration of services of added value as: identifier of calls, blockade of calls, detour of calls, voice mail box, interaction with database, etc. [2]

B. *Disadvantages of the telephony IP*

- Limitation of the bandwidth in the channel of communication.
- Loss of the service by means of the existence of courts in the electrical fluid constants.
- Problems with the time of response and the loss of packages.
- Susceptibility to virus, worms and to correct of hacking (they have been solved whenever the technology advances).
- Affectation in the quality of communication, if the equipments are not to the same technological level.

C. *Structure of the protocols of the telephony IP* [3]

Protocols of signposting

The protocols of signposting have the aptitude to exercise the control on the establishment, duration and ending of a communication between different sites or devices.

Transport Protocol

The protocols of transport are the managers of guaranteeing that all the information comes from the origin to his destination, expiring with the requirements of an efficient communication as bandwidth and quality of service.

D. Códecs of Audio

The audio códecs are the way that is used to convert a sign of analogical voice to foxglove, across the digitalization, codification, compression and decodificatión of the signs of voice by means of the use of mathematical processes with the purpose of adapting the information before being sent by the conduit.

In the table 1 are observed the characteristics of the audio códecs that are used in the telephony IP.

TABLE 1
Códecs of audio for the telephony IP

Códec	Technology	Apprais es Bits (Kbps)	Size Plans	MOS
G.711	PCM	64	0.125	4.1
G.726	ADPCM	32	0.125	3.85
G.728	LD-CELP	16	0.625	3.61
G.729	CS-ACELP	8	10	3.92
G.722	SB-ADPCM	64	0.125	4,5
G.723	MPMLQ	6,3	30	3.9

E. Equipments of the telephony IP

The structure of one network of telephony IP is composed by the following fundamental devices: servants of telephony, telephones IP, Softphones, analogous cards or digital adapters IT TIES and Gateway.

Servers of Telephony IP

These equipments are the managers of the enrutamient, addressing and control all the telephonic calls, in addition they have the functions of administration, control and managing database of the users' record. Also they allow the connection between the telephones IP of a certain organization with the telephonic traditional network.

IP Phones

The telephones IP are equal that the conventional telephones with the difference that the telephones IP have a variety of advanced functions due to the fact that they have a processor built-in and use an operating system that one allows them to adapt to the networks IP across a Switch or Router. In addition it realizes the functions of codification and decodificatión of the audio signs and video.

Softphones

A Softphone is an application multimedia that allows to emulate all the functionalities that there offers a telephone IP, since it is the accomplishment of telephonic calls to any destination.

Analogous cards

The analogous cards are used for the connection of the analogous lines of the PSTN by the telephones IP across the utilization of modules by interfaces FXO (Foreign eXchange Station) y FXS (Foreign eXchange Office).

Digital cards

The digital cards are used for the connection to a telephonic system of great capacity or to the PSTN, this type of cards have digital interfaces type E1 or T1, the same ones who allow handling a considerable number of circuits.

Adapter of Analogical Telephone ATA

The Adapter of Analogical Telephone is a device that allows connecting an analogical telephone to a head office of telephony IP, this device in general has an Ethernet port and several ports FXS and FXO.

Gateway of telephony

The Gateway is a device that has the aptitude to turn all the telephonic calls that are generated on the conventional lines to calls telephonic IP.

III. Protocol IPv6

The protocol IPv6 is nowadays the Internet protocol of new generation, which was developed by the IETF and is specified in RFC 2460. This one was designed by the aim to solve several limitations that they presented in the protocol IPv4. Other IPv6 is considered to be a robust, efficient and scalable protocol due to the fact that it combines the addressing extending with a more efficient head-board and with many characteristics in different areas as routing, safety, privacy, quality of service, mobility, mechanisms of transition, in addition it allows the coexistence of new protocols with protocols of previous versions as IPv4. [1]

A. Characteristics

Between the most important characteristics that there has the protocol IPv6 like: [4]

- Major space of addressing
- Security
- Real time Applications
- Autoconfiguration
- Mobility
- New format of head-board
- Levels of hierarchic addressing
- Extensibilidad

B. Format of the head-board of IPv6

The protocol IPv6 is a version improved to that of the protocol IPv4. This protocol presents a new format of the head-board of the package IP in relation to IPv4. The design centred basically on the simplicity of the head-board due to the fact that it is formed by 8 fields and his length is 40 Bytes.

In the Fig. 1, observes the format of the head-boards IPv4 and IPv6, besides the different fields that have.

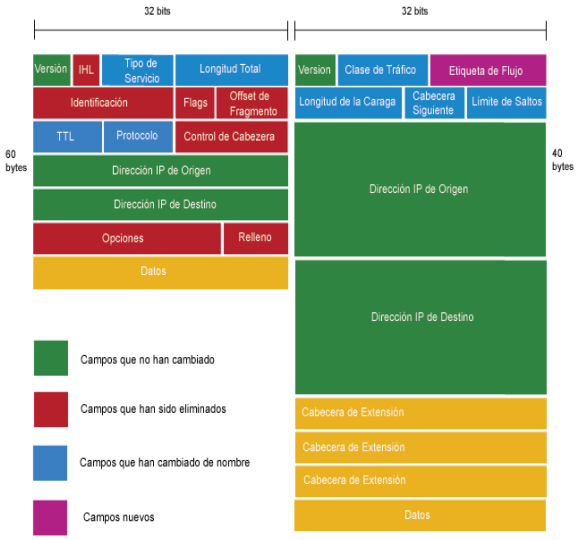

Fig. 1 Format of the head-board IPv6

- Version
- Class of traffic
- Label of flow
- Length of useful load
- Following headed
- Jump limit
- Direction origin
- Target Direction

C. Structure of the direction IPv6

The structure of a direction IPv6, it is described in the RFC 4291. This one has 128 bits of length, which are divided in 8 fields of 16 bits (in comparison with IPv4 a direction IPv6 is four times bigger), and every field consists of 2 Bytes those that are represented in hexadecimal format (000-FFFF) and separated by 2 points ":". A direction IPv6 basically consists of three principal parts as it is indicated in the Fig. 2.

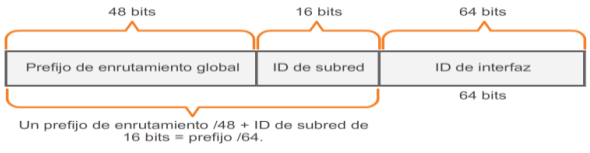

Fig. 2 Structure of the direction IPv6

- **Prearrange of ruteo globally:** This one uses the first three fields of the direction IPv6, which is assigned and structured by specific sites like RIR's and IPS's.
- **GO of subnetwork:** This one uses a field of the direction IPv6, and is the identifier of the network inside a site**.**
- **GO of interface:** It uses the last four fields of the direction IPv6, to identify the interface. [5]

D. Types of direction IPv6

In IPv6 different types of directions exist and not they all are handled equally. IPv6 defines three types of directions like:

Directions Unicast

The directions IPv6 unicast identify of exclusive form an alone interface in a device enabled with IPv6. And they qualify in the following directions. [6]

Directions Multicast

"The direction IPv6 multicast is in use for sending the only package IPv6 to several destinations".

These directions use the following prefix 0xFF, in addition a field of 4 has bits that are flags that are reserved and must be formed in zero. Whereas T=0 indicates that the direction is permanent and is assigned by the IANA, on the other hand yes T=1 indicates that the direction is dynamic. The field area is used to indicate the scope of every direction multicast. The identifier of group indicates if the permanent or dynamic group. [7]

Directions Anycast

The directions IPv6 anycast are directions IPv6 unicast that can be assigned to several devices. The packages sent to a direction anycast routing to the nearest device that has this direction. [6]

IV. Design of ToIP's system

The design of a system of ToIP based on Asterisk on the protocol IPv6, will be realized by

the purpose of having a system of communication of good quality and high availability that guarantees scalability, flexibility, hardiness and integration with systems of conventional telephony and mobile telephony.

Besides the fact that it is capable of offering some advanced functionalities of a telephone central office as: message of welcome, transference of calls, conference of groups, capture of calls, etc.

ToIP's system design, one does not try to follow any norm or specific standard. If not that will be realized on the basis of an analysis of several factors as the software that will be used for the telephonic service, the bandwidth that must have the link for the transmission of the voice, the connection that must exist towards the PSTN, the type hardware that it must use to support a certain number of calls and other additional services in order to have an efficient and feasible solution.

A. *Specification of the requirements for ToIP's system*

In agreement to the information that was obtained in the company one determined that ToIP's system that will be implemented in the company Sinfotecnia, needs the following requirements:

- The platform of software that will be in use for the service of telephony must be under license LPG (License Publishes General) and Open Source (Opened Code).
- Each of the internal departments belonging to the company, have a telephonic extension correctly registered.
- Each of the departments could communicate with others, across a telephonic call to his respective extension. To others all the departments must have access for the telephonic calls from and towards the PSTN and to cellular operators.
- All the telephonic calls must have a good quality and a high availability.
- The system of telephony could offer additional services as: capture of calls, IVR, transference of calls, conferences, etc.

B. *Dimensionamiento of ToIP's system*

The dimensionamiento of the IP-PBX, will carry out it across an analysis of the following factors as: package of voice, códecs of audio, (needed) bandwidth, number of (supported), main calls, etc.

Length of the Package of Voice

The package of voice is formed by the quantity of information that has the payload of the códec and of the length of each one of the head-boards of the protocols RTP (12 Bytes), UDP (8 Bytes), IP (40 Bytes). In the Fig. 3, there appears the length of the package of voice.

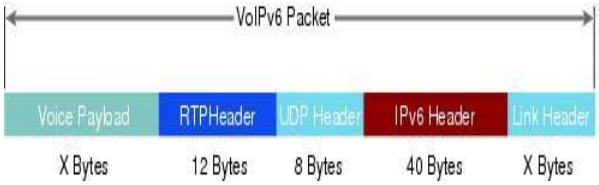

Fig. 3 Length of the package of voice in IPv6

The length of the package of voice fulfils across the equation 1.

$$LP_{voz} = L_{encapsulacion} + L_{sobrecarga} \quad (1)$$

Where:

- $L_{encapsulacion}$: Length of encapsulatión (sum of each one of the head-boards of the protocols that form the package of voice).
- $L_{sobrecarga}$: Length of the overload of the códec.

Bandwidth of VoIP's códec

The bandwidth that a códec needs for the transmission of voice needs of two fundamental components that they are the packages in second that the códec transmits and of the total length of the package of voice.

To determine the bandwidth that the códecs need the equation is in use 2.

$$BW_{codec} = \frac{(PPS * LP_{voz} * 8)}{1000} \quad (2)$$

Where:

- *PSS:* Packages per second.
- LP_{voz}: Length of the package of voice

Number of simultaneous calls

The quantity of simultaneous calls that the servant of telephony will support depends on the códec that is in use for the transmission of the voice. This parameter can decide on the basis of a relation between the bandwidth that has the link of the network on the bandwidth of the códec that will be used in a telephonic call.

To determine the quantity of calls that there were supporting the servants of telephony IP the equation will use 3.

$$N_{Llamadas} = \frac{BW_{Enlace}}{BW_{Códec}\ x\ 2} \quad (3)$$

Where:

- BW_{Enlace} : It is the bandwidth of the link.
- $BW_{Códec}$: It is the bandwidth of the códec.

TABLE 2.
Bandwidth of the audio códecs for the ToIP

CÓDEC	L.P.Voz (Bytes)	BW (Kbps)	LLAMADAS SOPORTADAS
G.711	234	187.2	22
G.723	98	55,2	78
G.726	154	123,2	33
G.729	94	75,2	54
GSM	106,5	85,2	48
Spexx	149	119,2	34

C. Dimensionamient of the bandwidth needed for ToIP's system

The bandwidth that needs ToIP's system that will be implemented in the company Sinfotecnia, was determined on the basis of the number competing calls that they deal in a period of time. Where it thought that they are six the competing calls due to number of internal departments that the company has. Whereas the bandwidth that will be in use for the telephonic conversations will be that of the códec GSM and to determine the bandwidth that needs the system the equation is in use 4.

$$BW_{ToIP} = N\ x\ BW_{Códec} \quad (4)$$

Where:

- *N*: It is the number of competing calls.
- $BW_{Códec}$: It is the bandwidth of the códec.

Replacing the values of the number to competing calls and bandwidth, of the códec in the equation4. One determined that the bandwidth needed for the implementation of the system of telephony in the company Sinfotecnia is 511,2 Kbps.

$$BW_{ToIP} = 1022,4\ Kbps$$

D. Design of the plan of bearing

The plan of bearing is the fundamental part of ToIP's system, due to the fact that this parameter is the one that one entrusts of the processing of

all the calls that enter and go out from the servant of telephony towards and from the internal departments, the PSTN, the cellular operators and to the Internet.

The plan of bearing is formed of the following elements that are: contexts, extensions, priorities and applications

The design of the plan of marked for the company Sinfotecnia, it will be realized by the purpose of having a better structure of the traffic of the telephonic calls that they will deal for ToIP's system, and on the basis of the functionalities that this one will fulfill the following contexts were created: internal, local, national, cellular, services and emergencies

In the company Sinfotecnia it was decided to create an extension for every internal department that has in each of the dependences. In the counterfoil there will be in use the numeration of 100X whereas for the branch his numeration will be it 300X and his distribution will be of sequential form without any identification especially. In the table 3 the extensions are observed of each one of the dependences.

TABLE 3.
Bandwidth of the audio códecs for the ToIP

EXTENSIONS	DEPARTMENT
1001	Receipt
1002	Administration
1003	Networks
1004	Technical Support
1005	Technical Support
1006	Sales
1007	Engineering
1008	Manages
1009	Trainings

E. Addressing IPv6 for ToIP's system

For ToIP's system the following directions will be in use 2002:dirección:ipv4:6to4::/64; where the first four hexadecimal digits indicate that it is a question of a direction reserved for IPv6 for the creation of tunnels 6to4. Whereas the following groups of bits (second and third party) represent the direction IPv4 (absorbed) in hexadecimal and following format it was representing the identification of subnetwork that the LAN will use. This type of directions will be in use due to the fact that none of the ISP`s (Suppliers of the Internet service) that drink in the Internet service in the company Sinfotecnia offer addressing IPv6 and like that across the utilization of the mechanism of transition (6to4) it will be possible have connection between the counterfoil and the branch.

In the Fig. 4, there appears the addressing IPv6 of the counterfoil.

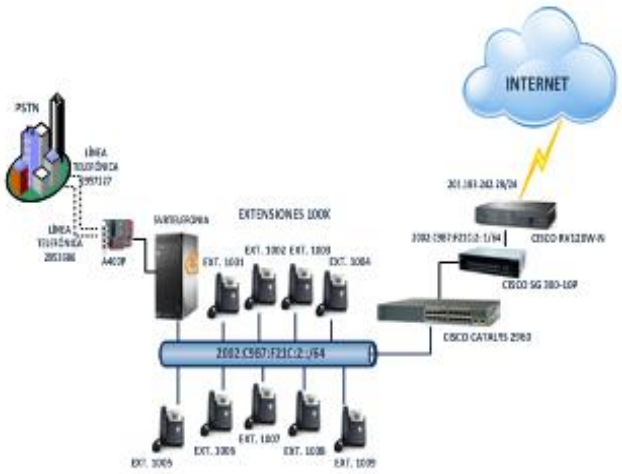

Fig. 4 Direcionamiento IPv6 in the counterfoil

V. Implementation of ToIP's system

For the installation of the software Asterisk it is needed principally of an operating system that he administers, control and manage the basic processes of the servant. The servants of ToIP will use the distribution of software free CentOS 6.8 as operating system the same one who is available in the official page.

A. Installation and configuration of the operating system.

The configuration for the support of the protocol IPv6 in the servants of ToIP realizes it

by means of the modification of the following records.

- vi /etc/sysconfig/network
- vi/etc/sysconfignetwork-script/ifcfg-eth0

B. Installation and Asterisk's configuration

The installation and configuration of platform Asterisk, which was in use for the implementation of ToIP's system in the company Sinfotecnia consists of three fundamental packages like Asterisk, Dahi and Libpri.

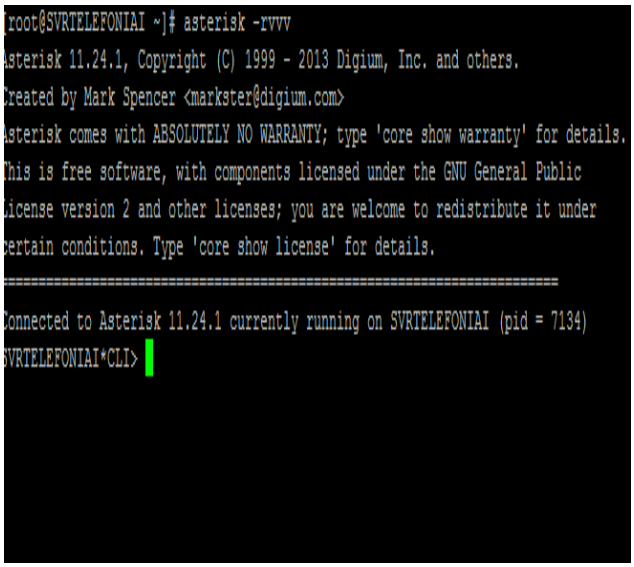

Fig. 5 Console of Asterisk's administration

C. Configuration and Extension record

The extension creation in every servant of ToIP they were realized by means of the specifications detailed in the design of the dialplan across the configuration of the file sip.conf, since it appears in the Fig.6.

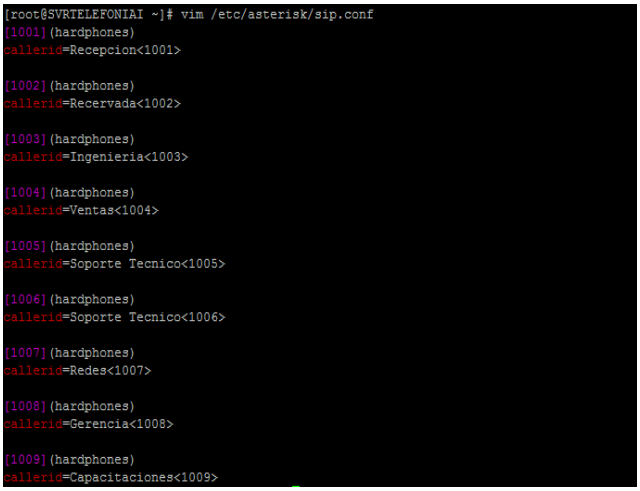

Fig. 6 Extension configuration in Asterisk

D. Installation of Telephones IP

The telephones IP were located in each of the departments from the company of agreement to the distribution of the points of network that was realized in the design of ToIP's system, in the Fig. 7 is observed the telephone IP that was installed in the department of management.

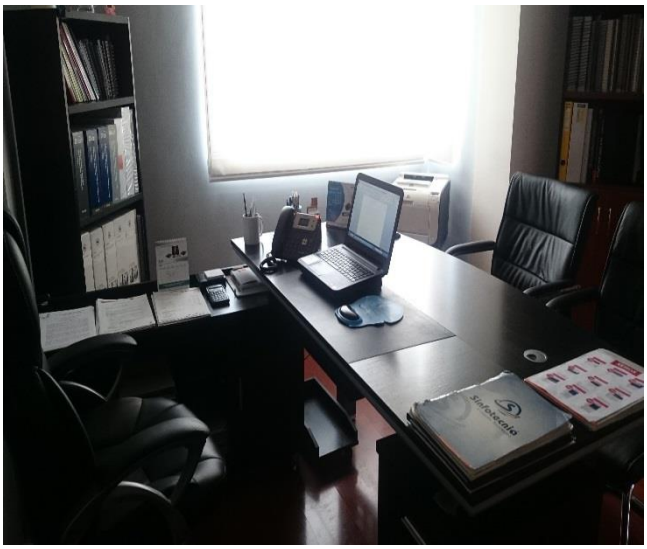

Fig. 7 Installation of the telephone IP in management.

E. Try Functioning of ToIP's System

The tests will be realized by the aim to examine the correct functioning of ToIP's system that was implemented in the company

Sinfotecnia, these were executing across the production of telephonic calls the extensions registered in the servants Asterisk and the PSTN.

After realized credit the tests of functioning of the telephonic calls was observed that the traffic RTP that it deals for the servants of telephony IP uses an approximate bandwidth of 85 Kbps.

In all the realized communications was observed that the values of the jitter generated during the telephonic calls are acceptable since none of these values is top or are ceca to the minimal value recommended for this type of communications that is of 100 ms.

Also was observed that in the different types of telephonic calls that were effected they turned out to be complete without any disadvantage a loss of packages being generated in average of 2 %.

In all the communications was observed that the values of the delay generated in the transmission of the packages during the telephonic calls are acceptable due to the fact that no package exceeds the time recommended for this type of communications that is of 150 ms

The utilization of the protocol IPv6 in the telephonic calls I turn out to be successful due to the fact that they all turned out to be complete without any disadvantage, in addition was observed that his decodificatión is not easy as in the protocol IPv4.

VI. Conclusions and Recommendations

V.II. Conclusions

The design and implementation realized a system of ToIP based on the platform Asterisk on the protocol IPv6 in the company Sinfotecnia, which allows to have a service of permanent communication between the employees of each one of the internal departments of the dependences and with his clients, at the same time it helps to effect the control of the telephonic service from an alone console of administration guaranteeing of this form that the company possesses a system and sure of telephonic communication convergent, reliable.

With the theoretical review of several fundamental concepts related to the technology of the VoIP, the platform of telephony Asterisk and the Internet protocol IPv6 it managed to determine that the ToIP based on Asterisk is a technological application that at present enjoys a great acceptance due to the characteristics that it has and to the advantages that it offers since is the aptitude to join with the former ones and the new applications, services and protocols of communication.

In the analysis of the current situation of the company it managed to verify that the system of electrical flow as well as the system of wired up structured they are in good condition and expire with all the specifications, standards and certifications that need this type of systems, in addition was observed that the infrastructure of the devices of connection of network has support for the implementation of the protocol IPv6 and with the monitoring of the network it was possible to specify that the traffic that flows for the network uses a bandwidth of 1,80 Mbytes whereas the intensity of the telephonic traffic is 0,98 Erlangs.

The minimal requirements were determined for the dimensionamiento of ToIP's system in the company by means of the analysis of several parameters as the length of the package of voice (234 bytes), bandwidth of the códec, number of main between others; and of this form it was achieved to establish that the total bandwidth needed by ToIP's system is 1.0224 Mbytes, for a quantity of 12 users and with the utilization of a códec of 42, 6 Kbps (GSM).

In the tests of functioning realized to ToIP's system, was observed that all the telephonic calls inlet and projections were complete from the origin to the destination checking so the values of the parameters that influence a telephonic call as

the jitter, the latency and the loss of packages are acceptable in relation to the minimal values recommended for this type of communications guaranteeing of this form quality in the telephonic service.

V.III. Recommendations

The utilization of the platform Asterisk on ToIP's systems is highly advisable due to the fact that it has the aptitude to join with a sinnúmero of services and new applications of communication across the use of protocols standardized by international organizations.

One recommends to place a system of redundantly of electric power in the rack of communications with the purpose of avoiding courts in the whole telephonic service due to possible faults that could appear in the service electric power.

One recommends to realize an analysis of the network of before information the implementation of ToIP's system, to determine the technological resources that will be used in the execution of the above mentioned system across the review of the bandwidth that has the network for the implementation of the service of telephony and the support for the protocol IPv6 in the equipments of network to avoid possible incidents in the implementation.

Before beginning with the implementation of ToIP's system on the protocol IPv6 it is necessary to to have knowledge of the location and of the structure of each one of the directories that will be formed for the support of the IPv6 in the platform Asterisk.

After realized credit the tests of functioning of ToIP's system one recommends to extract a support of the whole configuration before any disadvantage that it could present as problems of hardware, I cut circuits, between others with the purpose of preventing the company from remaining isolated during a long period of time and this way the configuration to use in another equipment of calculation of equal characteristics that the servant of telephony.

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