PROPOSAL OF TRANSITION OF SERVICES OF IPv4 TO IPv6 FOR THE NETWORK OF DATA WIRED UP OF THE GOBIERNO AUTONOMO DESCENTRALIZADO MUNICIPAL SAN MIGUEL DE IBARRA

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***Abstract*— IP internet protocol version four (IP), allows that the devices have internet access, this resource, with the obvious technological advancement is running out significantly. IPv4 has approximately four billion addresses and because of the emergence of the Internet, it has completed day by day. For this reason, the Internet Engineering staff IETF, has created the new IPv6 protocol, as a solution to the shortage of addresses.**

The new IPv6 protocol enables to route three around three hundred forty sextillions devices, that compared to IPv4 it's unbeatable. The new protocol has been already implemented in networks it is expected to coexist with IPv4 until everything is handled with IPv6. So, it is necessary a transition mechanism to handle both protocols, while IPv4 continues to exist.

In Ecuador, the Ministry of Telecommunications and Information Society, by ministerial agreement No. 007-2012, executed an action plan to be carried out with operators in an orderly and coexistent transition from IPv4 to IPv6, ISP (Internet Service Provider), public and private entities and institutions. Therefore, in their electronic platforms should be generate IPv6 traffic. According to the provisions, the proposal for Gobierno Autónomo Descentralizado Municipal San Miguel de Ibarra, starts using this new protocol on the web and email services.

This project is to develop to use a transition mechanism for the coexistence of IPv4 and IPv6 protocols, based on the actions that the ministerial agreement has. To do this, it will be made an analysis of the current situation of the company, to verify the IPv6 support for hardware, software as well as, applications and services.

Finally, configuration is performed on equipment and services with a simulator of network, allowing to demonstrate the coexistence of the two protocols.

Key words— IP, WEB, IPSec.

I. INTRODUCCION

The internet, known also like the network of networks, in the actuality, is one of the most important services that allow to connect to several users situated in any part of the world, to access to the information that need any person, make electronic payments, consult values to pay, chat, observe images, listen music, download or go up videos among others.

The protocol IP used to establish the communication is IPv4, that is a direction of 32 bits of length and that allows to have 4,294,967,296 of only directions, however, this direccionamiento is being replaced by the protocol IPv6, due to the fact that in him handle directions of 128 bits giving place to 340.282.366.920.938.463.463.374.607.431.768.211.456 valid directions. In consequence, the networks are already migrating to the new protocol IPv6 because of the massive growth of the networks as it is it IoT (Internet of the Things).

II. ANALYSIS IPV4 AND IPV6

A. LIMITATIONS OF IPV4

- **Exhaustion of directions IP:** Although they handle 4.294.967.296 million directions, is not sufficient for the increasing demand of networks that exist nowadays. For this reason, it has used NAT, to assign a public direction to several private, is a good method to be able to reutilizer the private directions, but then goes to comport to that in the communications produce necks of bottle.
- **Support for the delivery of data in real time:** new Applications like video and audio, require QoS, thus, needs a flexible architecture that allow to face the challenge that supposes the mobility of his users.
- **Requests of Security to level IP:** it uses to guarantee delivery of packages, and the norm is IPsec. In Ipv4 this field is optional, whereas in IPv6 is compulsory.
- **Expansion in the routing table of Internet:** With the increase of nodes or servers that are connected to Internet, increase the routes of network by what the routers have to handle tables of enrutamiento with greater information and this produces an increase of

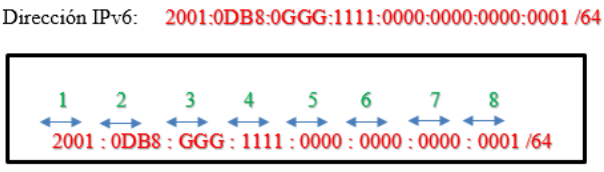
resources of the network regarding memory and processing.

B. *CHARACTERISTICS OF IPV6*

- **Greater space for direccionamiento of networks:** The protocol IPv6 has a length of 128 bits for directions so much of origin as of destination, in other words 2128 possible directions, unlike Ipv4 that has 232 directions.
- **Direccionamiento More efficient and hierarchical:** it Allows that the routers main direct the traffic of way faster and even that his tables of enrutamiento are much smaller.
- **New format of headboard:** it developed so that the routers make a lower consumption of processing when handling the information.
- **Configuration of directions:** With IPv6 can simplify the configuration in the hosts, allows the use of a server DHCP for the directions with state, and of equal way admits also the directions without state that are those that do not use a server DHCP.
- **QoS:** This allows to give him some type of priority to a traffic of data, by means of a field in the headboard of IPv6 (Class Traffic), allowing that the routers provide special treatment to a determinate flow of packages.
- **Security:** in IPv6 is compulsory the field IPSEC, that allows security of encryption to the useful load and authentication of the source of communication.
- **Interaction with neighbouring nodes:** Using the protocol Neighbor Discovery that Ipv6 has is able to handle a series of messages that goes to allow the interaction with the neighbouring nodes.

C. *DIRECCIONAMIENTO IPv6*

IPv6 extends his direction of 32 to 128 bits, that by the moment is sufficient to cover the big demand of users in the future. Four bits, represent a hexadecimal digit, therefore, a direction IPv6 consists of 32 hexadecimal values. To continuation, goes to present an example to help to the understanding of the same in the Figure 1: (CISCO, 2013)



It appears 1: *Representation of a direction IPv6 in octets*
Source: Own Elaboration

D. *TYPE OF DIRECTIONS IN IPV6*.

Each direction composes by 128 bits and exist three types of directions in IPv6 and are:

- **Unicast:** They identify to an only interface, this wants to say, that a destined package to a direction unicast will be delivered only to the interface identified with said direction. (CISCO, 2013)
- **Anycast:** These directions identify to a group of interfaces, in such a way that a package sent to a direction anycast will be delivered to a member that belong to this group, that generally is the nearest according to the distance assigned in the protocol of routing.
- **Multicast:** To the equal that the directions anycast, with the difference that a package that was sent to a direction multicast, is delivered to all the interfaces of the group. The directions of broadcast do not exist in IPv6, in replacement have created this type of directions. (LACNIC, 2012)

E. *PROTOCOL IPSec*

And a standard that provides security of the information, characterized for being powerful and flexible. It has created because of the failures that has the protocol IP that it is the security, this allows that the current networks access to critical applications as it is the one to handle information that involve business transactions. Of the same way, provides security independently of some application, of such form that turns it into an indispensable piece of the current networks.

Therefore, IPsec has turned into a basic component of the networks IP, thus it can consider a quite mature technology to implant it in networks whose priority was the security. If it speaks of security refers to the confidentiality and the integrity of the data that for a lot of companies is a fundamental requirement that his networks have to provide to the customers. IPSec Components of:

- Two protocols of security: IP Authentication Header (AH) and IP Encapsulating Security Payload (ESP) that provide mechanisms of security to protect the traffic IP.
- A protocol of management of keys: Internet Key Exchange (IKE) that allows to two nodes negotiate the keys and all the necessary parameters to establish a connection AH or ESP.

F. *COMPARISON OF IPV4 WITH IPV6.*

In the Table I, explain the main differences of protocols IPv4 and IPv6

G. *MECHANISMS OF TRANSITION*

The transition of IPv4 to IPv6 will not be possible to make it of a day for another, thus, is important to look for some solution so that the two protocols can coexist a time while all the networks migrate to IPv6 entirely. For example, treat to make updates of software in the nodes IPv4 current and define that teams are those that would have to change so that they handle IPv6.

TABLA I

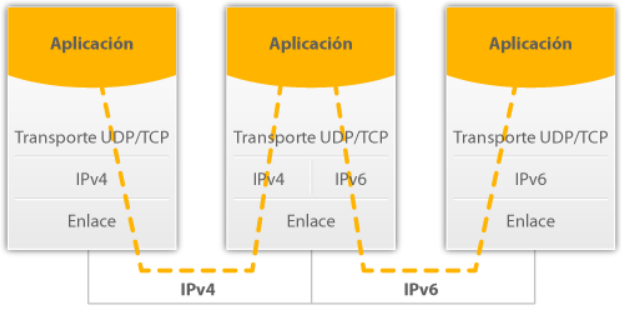
IPv4	IPv6
Las direcciones tanto de origen como destino son de 32 bits de longitud (4 Bytes)	Las direcciones de origen y destino son de 128 bits de longitud (16 Bytes).
IPSec es un protocolo opcional.	IPSec es una obligatoriedad.
No existe identificación de paquetes QoS que manejen los routers en sus cabeceras.	Con la utilización del campo flow label, se tiene entendido que se está manejando QoS
La fragmentación de un paquete lo realiza el host como el router, que produce retardos.	La fragmentación en IPv6 lo realiza únicamente el host, porque el paquete es procesado en el nodo final de destino.
Su cabecera tiene un cheksum.	Es eliminado el campo cheksum.
Se emplean solicitudes ARP para resolver direcciones IPv4, en una dirección de capa física	Las tramas ARP, son reemplazadas con mensajes multicast neighbor Discovery
Usan registros A, para la resolución de direcciones IPv4 a dominios.	Usan registros AAAA, para la resolución de las direcciones IPv6.
Se utilizan las direcciones Broadcast, para enviar un paquete a todos los nodos de las subredes.	Se utiliza una dirección multicast para poder enviar la información a los nodos de un ámbito local del vínculo.
Se debe configurar las direcciones de manera manual o utilizando DHCP.	No requiere de configuraciones manuales o utilizar DHCP.

Fuente: (Nuñez, 2009)

Dual Stack: it Is the most used method because it uses a node of double battery IPv6/IPv4 and can communicate so much a node IPv4 like a node IPv6. To achieve it, has to configure the two types of direccionamiento to each one of them. This mechanism allows to activate or deactivate one of the batteries, thus it goes to work of three ways:

- If it is activated the battery IPv4, will comport like an alone node IPv4.
- If it is activated the battery IPv6, will comport like an alone node IPv6.
- When they are activated the two batteries will work with the two protocols.

Remember that IPv4 uses to configure the directions uses DHCP or the static form, whereas IPv6 uses static configuration or DHCPv6. Of the same way, the DNS, has to be able to resolve the names of the directions in IPv4 as in IPv6, therefore, has to manage a node IPv6/IPv4, as it indicates in the Figure 2.



It appears 2: *Dual Stack*
Source: Recovered of http://portalipv6.lacnic.net/dual-stack-o-pila-doble/

Tunnels. The mechanism tunnel is used for the transport of packages IPv6 using an infrastructure IPv4. Besides, isolated computers IPv6 can establish sessions IPv6 extreme to extreme using IPv4 like the layer of transport. The tunnels have like purpose encapsulate packages IPv6 inside packages IPv4, that afterwards will be encapsulated to a node allocate IPv4 on a network that handle IPv4.

Afterwards the node allocate will make the desencapsulación and will extract the packages IPv6. Take in account that, to be able to apply this mechanism, is necessary that the extreme nodes of the tunnel bear Dual Battery. (Network Information Center Mexico S.C., 2010)

This mechanism can be divided in two groups:

Manual tunnels: Those that to transport a package IPv6 have to encapsulate in a package IPv4, therefore, are tunnels point ready that they have to be configured manually. The configuration of tunnels between host and routers can make of the following ways:

- **Host to Host:** the host IPv6/IPv4 that are connected with infrastructure IPv4, can encapsulate packages IPv6 between them same.
- **Router to Host:** the routers IPv6/IPv4 can encapsulate packages IPv6 to his final destination.

Automatic tunnels*:* The nodes IPv6 can use directions that are compatible with IPv4, with IPv6 or 6to4, is a dynamic tunnel of packages IPv6 on an infrastructure of enrutamiento IPv4.

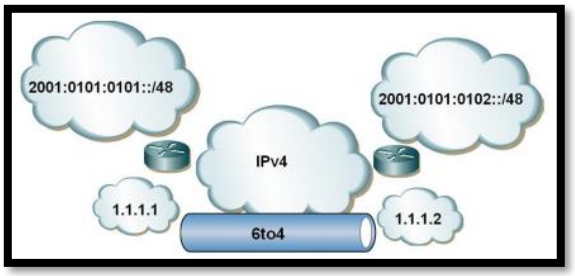
- **Router to Router:** it uses the automatic tunnel in where the routers IPv6/IPv4, separated by an infrastructure IPv4 can encapsulate packages IPv6 between them same.
- **Host to Router:** A host IPv6/IPv4 can encapsulate packages IPv6 to a router intermediate IPv6/IPv4 to

the witch can access by means of the infrastructure of enrutamiento IPv4.

Now they go to describe the technologies of the automatic tunnel:

- **Tunnel 6to4:** it specifies a mechanism so that the places IPv6 can communicate between yes through the network IPv4 without establishing explicit configurations of the tunnel. The network IPv4 comports like a layer of link point ready of unidifusión in where commands of IPv6 communicate through routers 6to4 called doors of link 6to4.

This method uses the prefix of global direction: 2002:WWXX:YYZZ::/48, WWXX:YYZZ: it corresponds to the GO of aggregation of the following level of a global direction. In the Figure 3 indicates the infrastructure of a tunnel 6to4.

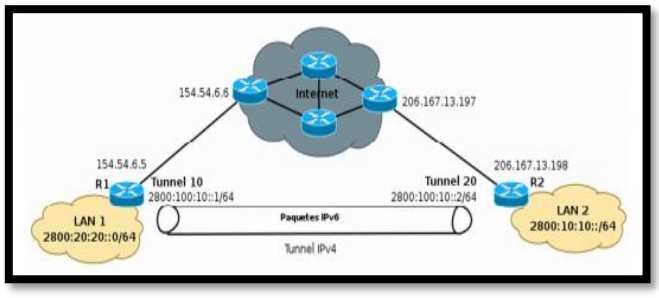


It appears 3: *Tunnel 6to4*
Source: (Cedeño., 2013)

- **Tunnel 6over4:** it calls it to him also tunnel of multidifusión of IPv4, where 6over4 admits the communication between nodes IPv6 and IPv4 through infrastructure IPv4, with capacity of multidifusión. For the good exert of 6over4, the infrastructure IPv4 has to be enabled for multidifusión IPv4.

In this mechanism, has to create a virtual link through a group IPv4 multicast with local field – organizacional, remembering that the mechanism multicast in IPv4 is optional. Therefore, the directions IPv6 multicast mapean directions IPv4 multicast to execute. For the routing between IPv6 and the command 6over4 is sufficient to configure a router at least in one of his interfaces. (Cedeño., 2013)

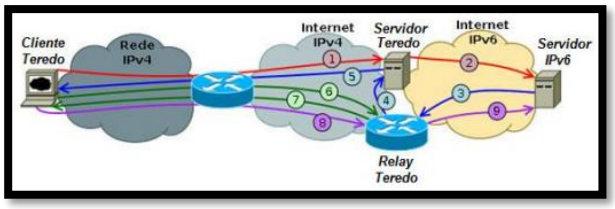
In the Figure 4 indicates the infrastructure of the tunnel 6over4



It appears 4: Tunnel Teredo

Source: (Palet, 2007)

- **Tunnel Teredo:** it was designed to guarantee the connectivity's IPv6 of the dual nodes stack, located behind the devices NAT on commands IPv4, that is to say, that defines the encapsulated of packages IPv6 in datagrams UDP IPv4 to be headed to trough of devices NAT and in internet IPv4. In the Figure 5 indicates a customer communicates through a tunnel Teredo with hosts IPv6 native. (Palet, 2007)



It appears 5: *Tunnel Teredo*

Source: (Palet, 2007)

- **ISATAP:** It allows to create tunnels IPv4/IPv6 of automatic form inside an infrastructure IPv4. Regarding 6over4 has some advantages, for example, does not need to use directions multicast IPv4 and solves problems in remote networks, like the drop scalability in the aggregation.

Translation. This method allows an enrutamiento of transparent form of the communication between nodes that bear already was the version four, the version 6 or the mechanism of double battery. They operate of distinct ways or layers, can be, translating headboard IPv4 in headboard. IPv6 and vice versa, conversions in the directions or the exchange of the traffic TCP to UDP (LACNIC, 2012)

H. SERVERS

A server is a team that is part of a network and caters of services to any another customer. It has to fulfil characteristics regarding hardware and software, besides be specialized with high capacities of process that allow to store several applications and that these are accessible by part of the users of a network, if like this they require it. (APR, 2016)

Types of Servers. A server can be devoted or shared. In the case to be devoted, this goes to loan all his resources to attend requests that a customer make and if it is shared, goes to be used to work locally in a network in which it plant it to him. (APR, 2016)

They exist some types of services eat:

- Database (BBD)
- DNS
- DHCP
- FTP
- Mail (Post/mail)
- Proxy
- SSH
- Multimedia transmission
- Telnet
- Web

In this case they will study the services that propose for the transition of IPv4 to IPv6 that they are: WEB and email. The election has made taking in account the availability of operation of the services that offers to the internal users like external.

- **Server WEB**. The word WEB is associated to Internet, due to the fact that they exist available browsers in any device with access to the network to access to these places that offer different type of information eat: archives, music, videos among others. (Digital corporation Colombia, 2016)

  Therefore, a server web is a place that houses any type of information that the user require by means of a browser that makes the exchange of information between the user and the server by means of HTTP that generally in the navigation web uses the port 80 and bases in the model customer server and of equal way HTTPS with the port 443. (Tools WEB, 2013)

- **Server of email**. The mail or email, is the system that allows to send, receive and manage messages of users or customers, ones to other connected in a same network or users of other networks like the Internet. The exchange of these messages makes of asynchronous form, to attain the effective communication needs of some protocols that are: POP, IMAP and SMTP. These protocols provide the interaction (transmission and reception) of email between computers and servers, with characteristic or specific functions between each one.

III. Approach of the Model of Transition and Analysis of Security in IPv6

It designs a model of transition in which they can implement the actions stipulated in the master plan that finds in the ministerial agreement, that allow to make an orderly transition and coexistence of the two protocols. Likewise, analyses the critical points in which it would have to implement the protocol IPsec that allow to offer security to the network of the Autonomous Government Decentralized Municipal San Miguel of Ibarra.

A. PLAN OF ACTION PROPOSED BY THE MINISTRY OF TELECOMMUNICATIONS (MINTEL)

Here they explain the general contours that the MINTEL has proposed so that it carry out the transition of IPv4 to IPv6. In the Figure 6 explains a model generalized of the methodology employed.

It appears 6: *Transition and Coexistence of IPv4 and IPv6 in Ecuador*
Source: Recovered of http://www.telecomunicaciones.gob.ec/

B. MODEL OF TRANSITION OF IPV4 TO IPV6 FOR THE NETWORK OF THE AUTONOMOUS GOVERNMENT DECENTRALISED MUNICIPAL SAN MIGUEL OF IBARRA

To be able to carry out the transition of IPv4 to IPv6 in this company, is necessary that adjust the activities of agreement to the plan of transition proposed by the MINTEL, is as well as it has designed the model of transition for the Autonomous Government Decentralized Municipal of San Miguel of Ibarra in which they include the activities made in phases.

1. *PHASE I: Planning.*

In this phase is important to identify and establish the plans to future for the adoption of the protocol IPv6, determining the human resource required for the delegation of functions and responsibilities in each area and carry out the process of transition and coexistence of the protocol IPv4 and IPv6.

1.1. ***Selection of the personnel***. Has to choose to the engineers that work in the department TIC's of the entity, to fulfil with all the activities that this project sues.

1.2. ***Qualification and training.*** Has to make to the personnel of TIC's of the Autonomous Government Decentralized Municipal San Miguel of Ibarra, with the purpose to carry out the project with responsibility that requires.

1.3. ***Chronogram of activities.*** This goes to allow control that they make the willing activities in each phase. Has to treat to establish an approximate period of time in which it will culminate this process.

2. *PHASE II: Design*

This stage has like aim make the current analysis of the company, identifying the areas in where it goes to implement IPv6, the topology of network, among others, to verify the support of the protocol IPv6, of the same way select the services and applications that go to handle with the new protocol.

2.1. Analysis of the current situation.

It makes a complete study to physical topology, logic of the network of data of the entity.

- ***Horizontal wiring of distribution***

  It uses wire UTP Category 6, allows to interconnect the backbone with the areas of work. For the terminal teams, have overlapping boxes for simple and double takings, with cover of protection for the exits RJ-45 for voice and data.

  The interconnection of the horizontal wiring between the main building and the ancient building to the corresponding backbone, finds on the false sky using the metallic trays and for the points of the areas of work is distributed with canaletas.

- ***Vertical wiring or Backbone***

  This wiring fulfils the function to interconnect the wiring of distribution of each one of the different flats of the main building with the utilization of optical fiber and wire UTP with each one of the teams of communication that find in the Data Center.

  The backbone of the Autonomous Government Decentralised Municipal San Miguel of Ibarra interconnects with the teams of communication that situate in: the ancient building, the direction of Tourism and the direction of Culture by means of optical fiber, these arrive to the area of main distribution MDF, situated in the department of Management of Technologies of the Information main building. The areas of secondary distribution SDF find in: the ancient building first plant, in the first plant of direction of tourism and in the direction of culture in the third plant.

  The optical fiber is of type multimodo for the connection between the external dependencies of the Autonomous Government Decentralised Municipal San Miguel of Ibarra and monomodo between independent entities. It presents a certification ISO 9001 and fulfils with the specifications ISO/IEC 11801 certification Tier l in optical fiber.

- Areas of work.

  The terminal devices as they are computers, printers and telephones use patch cord UTP category 6/Class and, with connectors RJ-45 to the two sides fulfilling with the norms of the wiring structured EIA and TIA.

- **Analysis of the logical infrastructure of the network of data:**

The LAN of the Autonomous Government Decentralised Municipal San Miguel of Ibarra, has a direccionamiento IPv4 Class B (172.X.X.X) with a mask of network 255.255.248.0 that by the moment satisfies the capacity of users that handles the entity and by means of the existent equipment guarantees the availability of his services, besides allows to the network a big growth and scalability.

For a better administration of the network of the Autonomous Government Decentralised Municipal San Miguel of Ibarra, has distributed the network in VLAN's.

- **Physical topology of the Network of Data of the Autonomous Government Decentralized Municipal San Miguel of Ibarra**

To know and determine the teams that bear the protocol IPv6, is important to know the actual situation the of the physical infrastructure. In the actuality, the network is able to transmit and conceal signals of voice, data and video, access to Internet and also allows the sharing of archives.

Of the same way internally possesses services like institutional internal post, queries of the corresponding systems buildings, administrative systems, financial, among others services that favors to the exert of the activities of the entity. All handles with the protocol IPv4, more does not have any relation of coexistence with the protocol IPv6.

Of the same way, can see the connection of the switch core with optical fiber with the link of the provider Telconet, that provides a bandwidth of 18 Mbps to the Autonomous Government Decentralised Municipal San Miguel of Ibarra Also the connection of the physical servers albergados in the DatesC enter. Although in this project do not take in account the wireless links, can them to him visualize and are the links connected of red color. In the Figure 7, describes the physical structure of the local network of data, in which they can visualize the connections of the links LAN that go to the buildings of the so much internal dependencies like external.

Regarding the physical servers, can say that they are updated the operating systems that

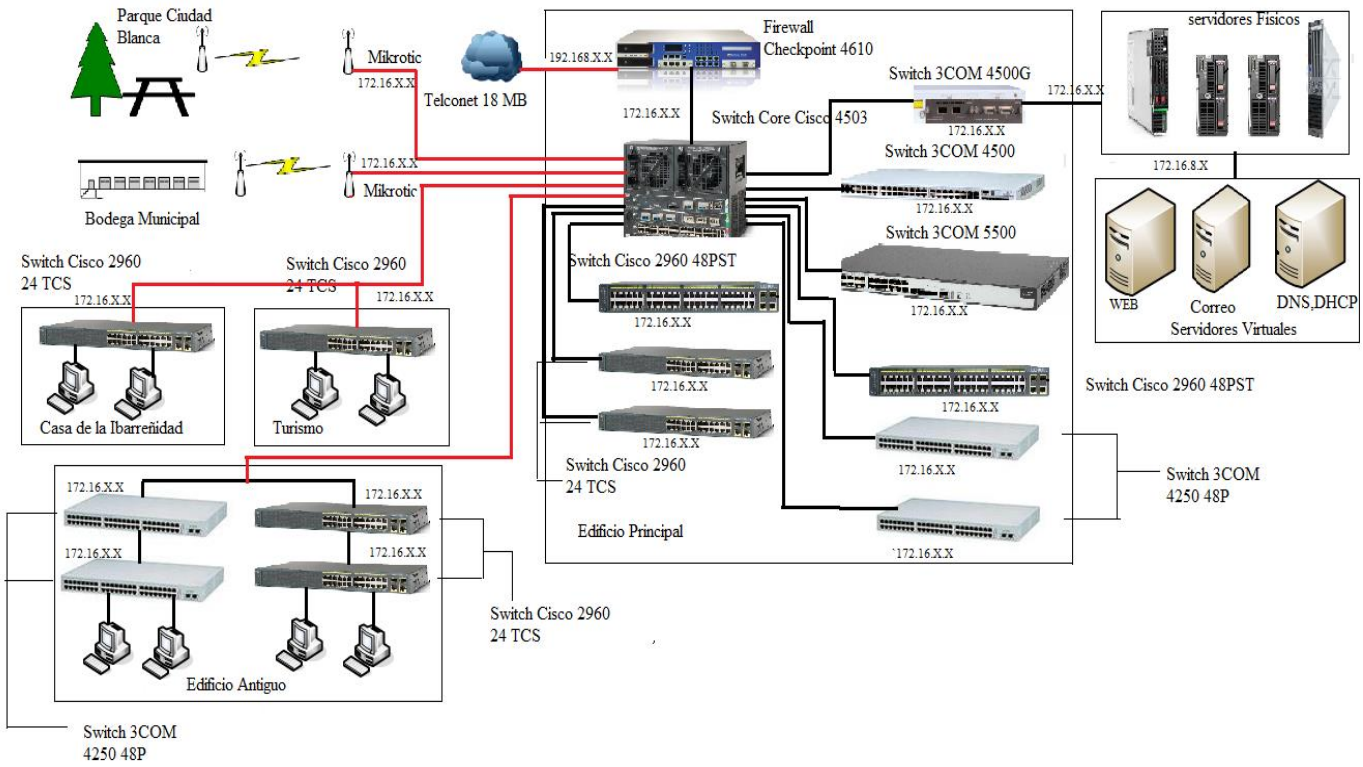


Figura 7: *Topología física de la red de datos cableada del Gobierno Autónomo Descentralizado Municipal San Miguel de Ibarra*
Fuente: Departamento de Gestión de Información

2.2. Analysis of Hardware or Equipment of the Network

Have to analyses the teams to determine if have the support IPv6, of which have to deepen in the following appearances:

- ***Time of use/ years:*** The teams of network, have an useful life of three years, that is to say his operation goes to be optimum in this time, but do not have to exceed the ten years of use. (Technical university Individual of Loja, 2010)
- ***Operating system IOS:*** The versions from 12.0()TS or T from now on, have the support IPv6. (CISCO, 2016)

Therefore, in the inventory made, the teams switch mark 3COM, have to be substituted, by not bearing the characteristics for the good exert of the network with IPv6. The equipment CISCO, works properly and his IOS are compatible with IPv6. In case to have an IOS, distinct recommends update it to upper versions to the 12.0()TS.

They house to the virtual servers. Po The so much the analysis typical of each operating system analyses in the following point.

The inventory regarding hardware, will allow to the present administration of the network know the apt teams for the implementation of the new protocol, or for updates in any team that do not have of the characteristics that has analyzed in this section.

2.3. Analysis of Software of the Teams.

It has made an analysis regarding the operating systems that handle the virtual servers and the computers of the users that has the Autonomous Government Decentralized Municipal San Miguel of Ibarra, in which the majority of final users use in his computers Windows 7 and Windows 8, and have the support for IPv6.

2.4. Selection of the services and applications selected for IPv6

As it has proposed the transition of IPv4 to IPv6 for the web services and Email, has explained already the importance that have for the entity therefore have in consideration the following recommendations:

- ✓ Has to take into account that they depend the others services, for example, in the case of server WEB, depends of the server of database, therefore, this service also has to have compatibility with IPv6.
- ✓ It has to exist the compatibility IPv4/IPv6, since some services do not go to be able to handle the two protocols, therefore, until they adopt IPv6 choose a mechanism that allow to keep coexistence between these two protocols.

2.5. Pool Of addresses IPv6.

It has to make the request to the provider of services Telconet. This ISP, at present handles and allows to have direccionamiento IPv6, the administrator of the network, has to make the formality required for the allocation of a block IPv6. In case that they did not have this support, exists the direct formality in the page of LACNIC: *http://www.lacnic.net/web/lacnic/ipv6-end-user*.

2.6. Analysis of the protocol of security IPsec for IPv6.

IPsec (Internet Protocol Security), is a standard created by the IETF that allows to provide levels of security to the layer of network IP and to other protocols of upper layers like TCP, UDP, among others. IPsec Has support for IPv4 as for IPv6, but in Ipv4 the use is not compulsory, whereas for IPv6 is integrated and his use is compulsory.

The main services of security that IPsec provides are:

- Integrity: Those packages that have not been changed or modified in the distance of the communication.
- Confidentiality: it guarantees that the content of the alone packages was known so much by the emissary and by the receptor.
- Authenticity: it says that the transmitter of the message, is the one who says to be.

For the implementation of this protocol IPsec in the network of the Autonomous Government Decentralised Municipal San Miguel of Ibarra, goes to make using ESP way tunnel. It is important to consider that this protocol can implement in final users, in servers or as in this case that it will be implemented in the gateways of the switches. For a better understanding of the application of this protocol goes to detail in the proofs of operation that have made for the network of the municipality of Ibarra.

SSL, of the same form is the protocol of security that implements in the communications of the entity, but in front of IPsec, which would be the most effective? As they go to determine the most important characteristics in the Table II.

Table II

Characteristics	**SSL**	**IPsec**
Applications	Enabled in web, use shared of archives, email	Borne for all the applications IP.
Enciphered	In the scale of moderate to safe because of the length of key of 40 to 256 bits.	In the scale of safe, because the length of keys is of 56 to 256bits.
Authenticity	In the moderate scale, is unidirectional or bidirectional.	In the safe scale, because of bilateral authentication by means of secrets shared or with digital certificates.
Complexity of Connection	In the low scale because it requires of a browser Web.	In the half scale due to the fact that it can result complicated without the sufficient technical knowledge's.
Options of connection	Any device can connect	Some devices with specific configuration

Source: Recovered of: http://ecovi.uagro.mx/ccna4/course/module7/7.4.2.4/7.4.2.4.html

When the security represents a problem, IPsec is the best option. If the support and the ease of implementation are the main problems, consider use SSL. But in this project will use IPsec to verify the operation with the protocol IPv6.

2.7. ELECTION OF THE MOST EFFICIENT MECHANISM FOR THE TRANSITION OF IPV4 to IPV6 FOR THE NETWORK OF THE AUTONOMOUS GOVERNMENT DECENTRALISED MUNICIPAL SAN MIGUEL OF IBARRA.

It is important emphasize, that the transition of IPv4 to IPv6, for the ISP's and the companies have to make it gradually and of the same way has to keep the interoperability if this effected. It is thus that looks for a mechanism of transition that allow to preserve the big investments that have made in networks IPv4,

and the mechanisms that have reviewed in the chapter II allow that the networks IPv4 with IPv6 keep interconnection between them.

The migration of IPv4 to IPv6, can be complex in big organizations, but using several strategies or mechanisms of coexistence go to help in this process of transition. The aim that this process arrived to make, is with the purpose that the costs of transition and the impact that produce in an organization or company are minimum.

To explain the advantages and disadvantages of each one of the mechanisms studied, goes to present the Table III (comparative) of each one of them for a correct selection of transition:

TABLE III

MECHANISMS OF TRANSITION

	Advantages	Disadvantages
Dual Stack	• Easy to implement. • Immediate solution more accessible. • There is no need of translation neither encapsulation • If it fails the network IPv4, will be available the IPv6, and vice versa.	• Has to keep two networks. • There is not reduction of demand of directions IPv4.
Tunnels	• They bear several platforms like CISCO, Linux, among others.	• They require know the two directions IPv4 (origin and destination), the two directions IPv6 (origin and destination), for the encapsulation. • It needs implement dual Stack in each one of the points of the tunnel. • They require greater configuration that the one of the others mechanisms. • If it leaves to handle IPv4, this infrastructure of network will have to migrate from zero to IPv6.
Translation	• It offers scalability to the network. • It allows the access to the two networks in the case that a device IPv4 want to communicate with an IPv6 and vice versa.	• They have the same problems that NAT in IPv4. • It produces necks of bottle. • They lose the profits of IPv6. • Has some incompatibility with some applications.

Source: (Cedeño., 2013)

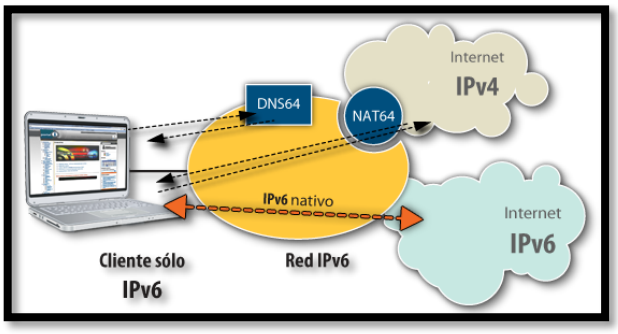
After having identified advantages and disadvantages go in of the mechanisms of transition, goes to choose the one who allow that it adjust to the characteristics of the network of the Autonomous Government Decentralised Municipal San Miguel of Ibarra. It is therefore, that goes to elegy the double mechanism battery or Dual Stack, due to the fact that it allows to implement the protocol IPv6 on a network of infrastructure IPv4.

Other mechanisms that go to use are the NAT64 and the DNS64. When lot network is IPv6 native and needs to arrive to places that are only IPv4 makes a translation using NAT, by means of a mapping between the packages IPv6 and IPv4. It uses a special prefix for mapping directions IPv4 to IPv6: 64:ff9b::/96, which finds defined in the RFC 6052.

It is necessary also make a modification to the DNS, call DNS64, that allows to generate a register AAAA although the destination do not have direction IPv6 (that is to say, the DNS answer only with registers of type To).

The native users IPv6 access directly to internet or to the cloud of applications IPv6, but when it needs go from a native user IPv6 to the cloud of to applications IPv4, NAT64 makes the mapping that needs ploughs to communicate to these users. When using a prefix /96 achieves that it makes an allocation of the last 32 bits of a direction IPv6 with the 32 bits of a direction IPv4

A direction IPv6 finds expressed in hexadecimal numbers, instead a direction IPv4 is in decimal numbers, therefore, NAT64 make the calculation that allows the conversion. In te Figure 8 evidence the process of this mechanism.



It appears 8: Mechanism of Translation

Source: Recovered of http://portalipv6.lacnic.net/mecanismos-de-transicion/

3. *PHASE III: Implementation and Analysis of proofs*

The final stage in which they make the configurations in the teams and make the necessary proofs of operation for the coexistence of IPv4 with IPv6.

3.1. Plan of direccionamiento IPv6

The Autonomous Government Decentralised Municipal San Miguel of Ibarra when having like provider of services of Internet to Telconet, can make a request to obtain a pool of directions IPv6 to this company, due to the fact that it is one of the ISP's in the Ecuador, that already handle his networks with the new protocol. This request is immediate, due to the fact that they already handle a block of allocation IPv4, therefore, the block of allocation IPv6 would have to be conceived without any problem.

3.2. Updates in Hardware and Software

Ploughs the teams CISCO, that do not have an equal or upper version to the 12.0()TS, has to effect the update of the IOS, of the following way:

1.- Ingress to the terminal of the team
2.- Verify the version with the commando *#show version*
3.- Download the .ISO for example: 12-2.55.se1
4. Erase the previous version with the commando *#delete /f/r flash1: c2960-ipbase-mz.122.35-35.se5*
5.- Copy the new version with the commando *#copy tpft flash1*
6.- Write in the memory, and restart with the commandos *#write mem and #reload.*

Finally, it enables IPv6:

*******Habilitation of ipv6********

Switch# Configure terminal
Switch(confg)# sdm prefer Dual-ipv4-and-ipv6 default
Switch(confg)# end
Switch# reload
****

In the case of software goes to take into account the following operating systems:

- ✓ Windows
- ✓ Linux

3.3. Configurations of the teams with IPv6.

In general, for the switches CISCO, that find in the topology of the network of the Autonomous Government Decentralised Municipal San Miguel of Ibarra, has to enable IPv6 with the following commandos:

*****Habilitation of protocol IPv6**********

Switch# Configure terminal

Switch(confg)# sdm prefer Dual-ipv4-and-ipv6 default

Switch(confg)# end

Switch# reload

3.4. Proofs of Operation

- Regarding the Internal network, could verify the access by part of a user IPv4, IPv6 or with the two addressing to the server WEB, that only handles IPv4. That is to say that for an user IPv6 access to this service, the server DNS64-NAT64, assigns an IPv6 to allow the access to this user. This process makes it of the following way:

  User ➔2001:db8:20:8::5678
  Application ➔ 172.16.8.6

  Special prefix for mapping directions IPv4 to IPv6:
  2001:db8:20:8:ffff::/96

  IPv4 in binary ➔
  10101100.00010000.00001000.00000110
  IPv4 in hexadecimal ➔ To C 1 0 0 8 0 6
  Special prefix + IPv4 hexadecimal = IPv6 Assigned of application
  IPV6 Assigned of Application ➔
  2800:68:19:2408:ffff::AC10:0806

- For an external user, this method goes to work of the same way, with all the rules of access that have configured in the Firewall.
- The mechanism implemented double battery, works properly since it allows to users with IPv4, IPv6 or dual customers Stack, access to the services. This mechanism is easier, however, is not the only solution if only it supports in this criterion, due to the fact that no all the

applications or services go to have compatibility with IPv6, is here where uses the server DNS64-NAT64.

- The have working two mechanisms of transition, sues the utilization of more resources of the network, what is not optimum, but while the networks to adapt to use IPv6, is a quite reliable solution.
- In server of post, accesses to the applications IPv4, although it handles only IPv6, this is because of the DNS64, that allows to create registers AAAA, to keep the connection to these applications that in a lot of cases are not compatible with IPv6. They will exist some new applications that handle the new protocol, and this is a solution that could use in so much handle like native protocol IPv6.
- The teams of network, work of way much faster with IPv6, due to the fact that it analyzed that they make lower processing because the headboard is much more efficient, analyses fewer fields in the same, what allows that the communications are swifter.

3.5. Monitoring of the network with the implementation of IPv6

The monitory of the network is a notable subject in the networks of nowadays, as they can analyses several factors that determine resulted that to the administrator can alert him of several profits or problems. In this case, analyses the traffic IPv4 or IPv6 of the different services of network, goes back important because this allows to determine the use of the protocol with which is connected to the Internet. (It puts to bed, 2014)

Of the same way, allows of agreement to the results that evidence this monitory, goes to be able to determine actions to solve the problem and conform plans of contingency so that the services of the network work properly and the users do not have inconvenient to the moment to access to any one of them. (It puts to bed, 2014)

For this reason, it has analyzed if the network of the Autonomous Government Decentralized Municipal San Miguel of Ibarra, has some tool that allow to analyses the traffic of network and sure enough exists implemented in the network the tool SNMP (Simple Network Management Protocol), that allows to monitor the traffic that crosses by determinate device between other advantages. It is necessary to take into account that the team that monitory is the one who has to bear SNMP for IPv6.

Also, the tool Wireshark allows to analyses with which protocols is working, that can be with IPv4 or IPv6, filtered of packages among others. It exists the tool Net Flow that unlike SNMP, allows to obtain more information in addition to the load of traffic in the interface, for example, address origin and destination or the protocols of the upper layers that cross the interface. (It puts to bed, 2014)

As it observes, they exist a lot of tools that can be taken advantage of for the monitory of the network, any one of them that use, will allow to analyses if the network, begins already to use the protocol IPv6 in his services and if the users do use of the same.

3.6. Risks and plan of contingency with IPv6

Definitely that a technological project of this type, can have several risks, that's why they go to explain in the Table IV the which can be:

TABLE IV

RISKS TO IMPLEMENT IPv6
Physical damage in the equipment of hardware
Loss of information
Incompatibility in hardware or software
Unsteadiness of the applications
Problems with the operation of the Operating system
Fault of commitment by part of the personnel of the Department of Computer Technologies
You fail of installation and connection of teams
Fault of time of adaptation to the new protocol IPv6
Fault of qualification to the personnel of the Department of Computer Technologies

Source: Recovered of http://www.magazcitum.com.mx/?p=568#.WB-xu_nhDIU

Now, of the same way the risks of not implementing IPv6 are the following and show in the Table V

TABLE V

RISKS OF NOT IMPLEMENTING IPv6
Difficulty for the emergence of new networks
Lengthen the time of process of digital inclusion or reduce the quantity of new users
Hamper the emergence of new applications
The cost of not implementing IPv6 will be able to be greater than the one of not to implement it
Limitation of the ISP's for innovate and offer new services to the customers

Source: Recovered of http://www3.lacnic.net/eventos/lacnic23/miercoles/guillermo-cicileo-ipv6-para-tomadores-de-decisiones%20copy.Pdf

Finally, it goes to analyses the plan of contingency, for goes to allow warn the risks with the aim to guarantee the good exert of the project that ensure a be efficient vice. In the Table VI, indicate the actions that have to carry out to warn the risks described previously.

TABLE VI

Plan of contingency
Back all the information in devices of storage like hard disks, memories USB, among others.
Review the manuals for the manipulation of the teams of communication.
Make the maintenance and review of the equipment of communication.
Supervise the applications that have implemented with IPv6.
Review the configurations and proofs of operation.
Make the updates of the operating systems continuously.
Execute plans of continuous qualification to the personnel of TIC's
Elaborate a chronogram of work that allow to supervise each one of the activities to each member of TIC's.
Evaluate to the personnel of TIC's with the purpose to reinforce knowledge's for the adoption of IPv6.

Source: Recovered of https://www.emaze.com/@AFRZQZOL/Plan-of-Transici%C3%B3n-IPv4-to-IPv6

IV. Analysis Cost-Profit

Sand goes to analyses the cost-profit of the project, that determine the advantages of a possible implementation. The private entities evaluate in terms of gain, whereas the public make the evaluation in terms of general welfare. That is to say that the Autonomous Government Decentralised Municipal San Miguel of Ibarra, when being a public entity, the aims that pursues like governmental institution, bases in the social general welfare, in other words has to look for the social profit improving the appearances: environmental, cultural, technological, among others. (Fabrycky, 2012)

4.1. Social cost

In general terms, the cost refers to the price that has to pay by an article. However, the proportionate money to the public entities is by part of the State, then lot moral obligation of the public entities is to invest productively this money. Put the analysis that pretends represent, goes to consider like a social cost. The social cost, is the one who has to pay the society when it occurs an act to use a resource, and this cost can be already included in the taxes that the citizens pay to the State. (Miller, 2010)

For the analysis of the costs go to consider the following appearances:

A. Technological Human/resource

They are the people that go to carry out the implementation of this project. The personnel of the Department of Technologies of the Information, has to be qualified due to the fact that it does not know a lot of the subject and is necessary that prepare in what it last this process.

Cost of qualification and implementation. To make the estimate of the cost that include the qualification to all the team that will participate in the project and the implementation for the protocol IPv6, has taken in account a preform that asked to the company Imbatec, because of his prompt answer. It is a company that loans the technological services required for this process since it has engineers with certification Cisco. Of the same way taking in account the courses that LACNIC offer for the knowledge suggested for this process that finds in http://www.lacnic.net/web/anuncios/2015-cursos-ipv6, has made the following analysis that presents in the Table VII.

TABLE VII

BUDGET OF QUALIFICATION And IMPLEMENTATION			
Description	**Quantity**	**Unitary value**	**Total value**
Human resource: 5 people for qualification	140 hours	$30	$4200
Implementation of the Project (Configurations in all the equipment of network)	80 Hours	$30	$2400
		Total:	$6600

Source: Preform Imbatec, Courses LACNIC.

B. *Hardware.*

Once that it has analyzed the equipment of network, could identify that they exist some teams that have to be substituted by others that have the optimum conditions to be able to work properly, due to the fact that these teams have already 10 years working, and according to the analysis made in the inventory of hardware have to make these changes. And regarding the support IPv6, the other teams, are smart to be configured.

Costs of Hardware. As it analyzed in the inventory of hardware, exist teams that have to be substituted for the adoption of the new protocolo. In the Table VIII, describe the teams that have to be substituted and the respective cost of each one of them.

TABLE VIII

BUDGET OF HARDWARE			
Unit	**Description**	**Unitary value (USD)**	**Total value (USD)**
2	Switch Of Access 4250T	1000	2000
2	Switch Of Distribution 4250T	925	1850
1	Switch Of Access 5500G/52	1046	1046
2	Switch Of Distribution 4500	1139	2278
		TOTAL	7174

Source: http://www.mercadolibre.com.ec/

C. Software

The Autonomous Government Decentralized Municipal San Miguel of Ibarra, uses in the majority of his operating systems free software. To make the simulation of this project did use of the same and used the following:

- Centos Versión 6 (Operating system)
- GNS3 version 1.3.11 (simulator of network)
- VMWare 11.1 (Platform for virtual machine)
- Wireshark 2.0.3 (Analyzer of network)

In the case of GNS3, VMWare and Wireshark are versions of software that already find freed.

Cost of Software. The free software is not synonymous of free software, free wants to say that they are those that his use, modification and distribution are allowed to all. However, for the installation in a team requires of units of storage in which it find the software. (Debian, 2016)

And the Table IX indicate the costs of the software used for the installation in the respective teams.

Table IX

BUDGET OF SOFTWARE	
Description	**Value (USD)**
4 DVD's S.Or Debian	12
4 DVD's Centos 6.5	12
TOTAL	24

Source: Recovered of https://www.debian.org/intro/about.es.html

D. Total cost of the project

In the Table X plant the costs of qualification and implementation, hardware and software that need for the setup of this project. Also it is important that consider 10% additional in case that it require hire additional advice in some configurations that can consider complex. (Diaz, 2008)

TABLE X

TOTAL BUDGET	
Description	**Value (USD)**
Budget of Qualification and Implementation	6600
Budget of Hardware	7174
Budget of Software	24
Unforeseen (10%)	1379.80
TOTAL	**15.177,80**

E. Reason Benefit Cost

To make this analysis, is important to consider that, for this governmental entity, cannot measure the gains in monetary values, rather these gains transform in profits that go to deliver to the internal users like external. Also the profits that will be directly for the network of data of the Autonomous Government Decentralized Municipal San Miguel of Ibarra. For this, go to describe these profits in base to indicators IPv4/IPv6 that have made along this study.

Autoconfiguración Of devices

- The characteristic plug and play, mechanism that facilitates to the users in this case to the interns the automatic connection to the network. This allows to facilitate the process of administration of the network, since it will assign to each user automatically one or several directions IPv6.

Quality of service to applications or services

- In the environmental appearance, can reduce costs, for example, if some civil servant of the entity has to travel to an important meeting in another place, can make from the company a videoconference, taking advantage of the improvement regarding quality of service.
- What facilitates the extreme connection to extreme, that allows to expand the ideas and give greater flexibility to developers, that of the same way reduces the costs of the technician mentioned previously.
- With the improvement in the headboard of IPv6 of label of flow, allows that the characteristics of quality of service that exist in IPv4, are improved in IPv6, guaranteeing that the applications in real time like videoconferences or VoIP that can be offered to the final user improve of this way.

Implementation of Smart machines

- When the implementation of IPv6 conclude, the greater part of traffic in the networks of communication will consist in transactions between machines without the intervention by part of the humans. This evolution will represent an important change in the sector of the communications.
- The quality of the experience for the user, can improve integrating the automation of processes in the entity with the help of intelligent objects connected with directions IPv6 only.

Creation of Networks of Sensors

- The networks of sensors that consist in autonomous sensors that collaborate in the supervision of physical and environmental conditions concrete. They will allow that it control several parameters like heat, temperature, pressure, sound, vibration, among others. They can integrate to intelligent systems that allow to be monitored each one, this will allow that the city go turning into a Smart City that will benefit to the living beings of the city of Ibarra.

Environmental project

- They can create some, for example, the control of speed of the public vehicles, that will allow to contribute to improve the security in the transport for the citizenship.
- Profits of electrical saving, can create an intelligent electrical network that have by aim modernize the electrical system with bilateral communications to supervise and manage the production, transmission and distribution of electrical energy jointly with the company Emelnorte, that contributes to the profit for the citizens. This with the deployment of IPv6 that see implemented in the Autonomous Government Decentralized Municipal San Miguel of Ibarra.

Security

- The security is an important appearance in any network, is thus that the protocol IPv6 includes this parameter and can provide encryption, authenticity and integrity of the information.

Access to applications or services

- The services or applications that handle Dual Stack, will allow that users so much IPv4 like IPv6 can access to them, due to the fact that all the requests that make to the applications from a host IPv4 answer from the servers IPv4, of equal way the requests of a host IPv6 will be answered from servers IPv6.
- When using the mechanism NAT64-DNS64, the native users IPv6 access directly to internet or to the cloud of applications IPv6, but when it needs go from a native user IPv6 to the cloud of applications IPv4, Nat64 makes the mapping that needs to communicate to these users.
- IoT (Internet of the things), is one of the most excellent appearances with IPv6, that will be the network that interconnects common objects instrumented with modules of intelligence miniaturizations, that will give foot to the development of big technological projects devoted to improve the quality of life of the citizens of the city of Ibarra.

V. CONCLUSIONS

- The development of the proposal of transition of services of IPv4 to IPv6 for the Autonomous Government Decentralized Municipal San Miguel of Ibarra, allowed to develop a model that go of the hand with the plan of action proposed by the MINTEL, allowing an orderly and effective transition for the coexistence of the two protocols.
- The study of the protocol IPv6, allowed to analyses the advantages that has on IPv4, for example, the autoconfiguration of the hosts, greater utilization of IP's, better processing of the information, mobility IP, increase of security taking advantage of the protocol IPsec.
- The equipment of network of the GAD-I, in some teams, requires the update of the IOS in specific in all the previous versions to the 12.0()T, in other cases is necessary to make the request of new teams because of his time of useful life in which it recommends that the teams do not surpass the ten years of use.
- And what to updates of software, in the operating systems that handle free software, the kernel required to work with IPv6 has two-party r of the version 2.4 from now on, fulfils with this aim and of the same way all they have the support for IPv6.
- It is necessary that analyses the server of database, due to the fact that the web applications like post need of the information housed in the same, therefore, has to analyses carefully which have to be the services that need greater priority of transition.
- The election of the mechanism of transition that has decided use is double battery or dual Stack, that allows to keep the network working so much in IPv4 as in IPv6, having like advantage handle the two protocols and have coexistence with the same. If it arrived to leave to use the network IPv4, the network IPv6 will be available, allowing that the network follow being available for all the users.
- To keep connectivity to users that only use IPv6 and have to access to applications that find only using IPv4, does necessary the implementation of a translator DNS64 and NAT64, which will assign an IPv6 to the application IPv4 by means of a translation that achieves mapping a direction IPv4 to an IPv6.
- Regarding security, has decided take advantage of the protocol IPsec, since his use is indispensable for example in the server WEB, due to the fact that it handles delicate information, therefore, has implemented in devices of gateway of security or called also like intervals using the way tunnel with encapsulation ESP, which provides authentication, integrity and confidentiality in the packages transmitted.
- When making the analysis regarding costs and profits, determined that the GAD-I, when being a governmental entity, when it generates a project, does not expect that they generate economic gains and that recover the money invested in a period of time, rather translates to social profits that allow to obtain satisfaction to the users.

- With the protocol IPv6, has capacity for more users, more networks, this advantage of IPv6 can be taken advantage of for the implementation of technological projects that have relation with the subject IoT, that the GAD-I, can take advantage of and work in group to attain direct to the city of Ibarra to be a Smart City.

- This project, is made with the purpose that the public companies or deprived of the city of Ibarra, motivate to start with to deploy IPv6 in the networks, so that they take advantage of all the profits that has when using the protocol of new generation.

- IPv6 present significant opportunities to create innovative business models, this due to the fact that they can assign only directions to daily devices connected what will allow the generation of applications and technological services that will allow the automation, productivity and efficiency of the company that handle his network with the new protocol.

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