

# REENGINEERING OF THE INTERNAL INFRASTRUCTURE OF DATA OF THE “COOPERATIVA DE AHORRO Y CRÉDITO SAN ANTONIO LTDA.” AND DESIGN OF WIRELESS LINKS TO YOUR BRANCHES

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**Abstract—** The Cooperativa de Ahorro y Crédito San Antonio Ltda., is a private institution that provides financial services to the province of Imbabura, this study has aimed to make the reengineering of data network and design of wireless links to branches, in base to the hierarchical model of network and international wiring standards structured.

Reengineering of data through network analysis is used to determine the necessary equipment, in the layer core is redundancy, high speeds and features of L3 layer, the distribution layer is responsible for security with access-list and Inter-Vlan communication, coating creates access VLAN's and communication with end users.

Calculations for the transmission of data and simulation of the links are made in wireless links. In addition a simulation shows the operation of the model, the referential budget and analysis cost-benefit.

*Texts indexed—*LAN, VLAN, ANSI, TSB, EIA, TIA.

## I. INTRODUCTION

The Cooperativa de Ahorro y Crédito “San Antonio Ltda.” it is an institution that provides financial services, is located in the province of Imbabura, its parent company is located in the parish of San Antonio de Ibarra in the streets hermanos Mideros 633 and 27 November; currently has two branches located in the city of Ibarra in the streets Velasco (between Bolivar and Olmedo) and Atuntaqui Av. Salinas and Atahualpa 14-07.

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Document received in July 2015. This research was carried out as a previous project to obtain the professional title in the race of Ingeniería en Electrónica y Redes de Comunicación de la Facultad de Ingeniería en Ciencias Aplicadas (FICA) de la Universidad Técnica del Norte.

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The main objective is to achieve the financial development of the citizens of the parish based on the Organization of savings

and credit, actively participating in the social cultural life and sports environment, demonstrating that capacity will and order, social financial activity of the parish and their neighborhoods may have an integral development in the community.

The institutional life of the cooperative has been going through different changes, in relation to the furnished from their you offices and local data network growth was according to economic capacity and willingness of each of the authorities, so now the growth is significant and is now a financial institution recognized at the level of the province.

Based on the historical background of the growing network of the Cooperativa de Ahorro y Credito San Antonio Ltda., is considered proposing a re-engineering that will allow us to have a proper management process and where it meets the needs of the company, that the needs which are satisfied complies with future requirements.

## II. FUNDAMENTOS TEÓRICOS DE UNA RED DE ÁREA LOCAL

### A. Basic LAN concepts

Local area networks are important within a private or public undertaking, because based on the concepts of data networks that are transmitted and stored large amounts of data, through its improvement is more and better services to customers.

### Telecommunication network

It is a technological infrastructure that provides communication between multiple entities in a fast and compact way with greater benefits for the institution using rules or communication protocols.

### Data network

Data networks are born by a business need transmit information, modify it and update it quickly and efficiently. Before any users data networks had to use rigid media storage and just more complex was the displacement of this medium.

### Local Area Network

It is an interconnected system of high speed, which allows you to exchange information, share resources, services and

applications; a LAN can be constituted by at least two computers and a printer, is located within a same floor or building.

#### VLAN virtual LAN networks

A VLAN (Virtual Local Area Network) is a network of computers that are logically independent, arises from the need to manage logical groups in network. Various VLAN's can coexist in a single physical switch.

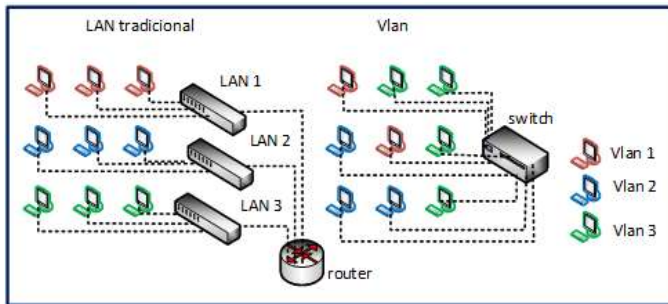


Figure 1. Traditional LAN y VLAN

Source: <http://goo.gl/XiP23z> Modified by: Esmeralda Patiño

#### B. Hierarchical network Model

Hierarchical network model allows you to have an understandable model and select appropriate settings in each of the layers. If a network is designed on the basis a hierarchical model is capable of supporting voice, data and video transmission. [1]

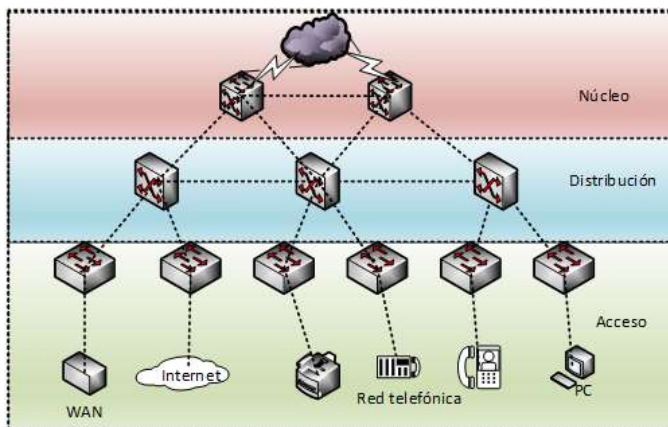


Figure 2. Layers of the hierarchical network model

Source: <http://goo.gl/7VYbLh> Modified by Esmeralda Patiño

#### Access Layer

The access layer has as main feature provide a means of connection with end user devices, printers, PCs and IP phones; for this reason, this layer is sometimes called job, desktop or user coating layer.

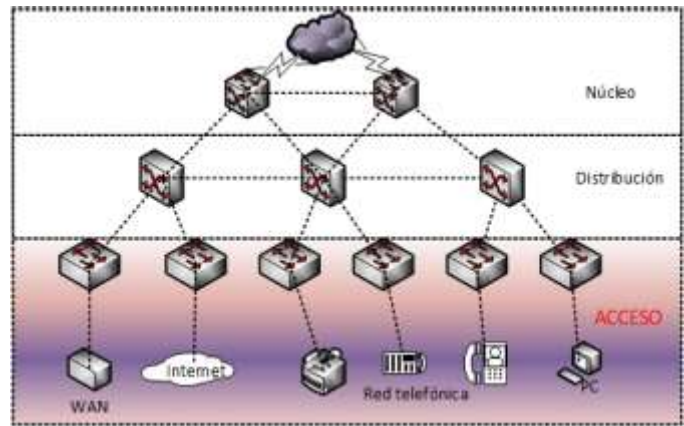


Figure 3. Access of the hierarchical model layer

Source: <http://goo.gl/7VYbLh> Modified by Esmeralda Patiño

Users as well as the resources that they need to access more frequently, are available at the local level. The traffic to and from local resources is confined between resources, switch, and end users. In the access layer we can find multiple groups of users with their corresponding resources.

In many networks, it is not possible to provide users with local access to all services such as databases, centralized storage, or dial-up access to the Web files. In these cases, the traffic of users who demand these services deviate to the next layer of the model: the distribution layer. [2]

#### Distribution layer

This layer is the medium access between the core layer and the layer as shown in Figure 4, which offers services to the end-users of the hierarchical network model. Its main functions include the routing, filtering and WAN<sup>1</sup> access.

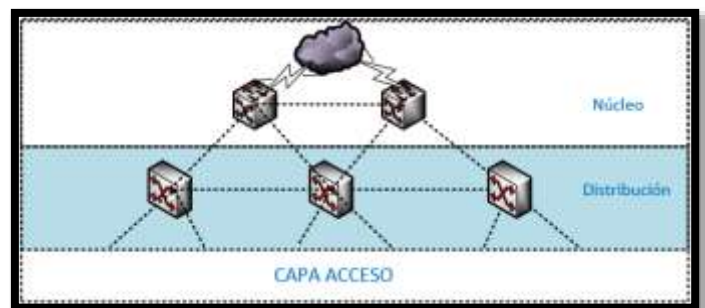


Figure 4. Layer Distribution the hierarchical network model

Source: <http://goo.gl/7VYbLh> Modified by Esmeralda Patiño

Distribution layer covers a wide range of functions, including the following:

- Serve as a single point to access access layer devices.
- Route the traffic to provide access to the departments or work groups.
- Segment the network into multiple broadcast domains / multicast.

<sup>1</sup> WAN: Wide Area Network is a network that exists over a large-scale geographical area.

- Translating the dialogues between different types of media, such as Ethernet and Token Ring.
- Provide security and filtering services.

Distribution layer can be summarized as the layer that provides connectivity based on the policies of the company, since it determines when and how packets can access the core services of the network. Distribution layer determines the quickest way that a user (such as a file server access) request can be forwarded to the server.

Once the distribution layer has chosen the route, it sends the request to the core layer. The core layer can then transport the request to the appropriate service. [3]

#### Layer core

Its main layer core in the design of a LAN-based hierarchical network model function is the high-speed backbone. Layer core is a very important part here is the interconnectivity between the teams of the distribution layer, therefore, it is important that the kernel is available and redundant.

In Figure 5 you can see the core layer and how is located within the hierarchical network model.



Figure 5. Layer Core the hierarchical network model  
Source: <http://goo.gl/4clyx0> Modified by Esmeralda Patiño

Layer core is the central layer of the network that makes it possible to network to function properly if this layer stops working across the network stops working, other roles is the treat large amounts of data, manage the traffic of reliable and efficient way, reason why latency and throughput are of great importance.

The most important features that should have this layer are summarized in two are:

#### Core of high availability.

To ensure the availability of the coating core, this should be redundant, which ensures that you continue to work if one of its components fails.

#### Fast Core.

Care should be taken to the network core to run at the maximum possible speed, is that the only function which should be limited to packet forwarding as quickly as possible.

#### C. Structured Cabling

Structured wiring inside a LAN is important to treat as depending on the characteristics and design of cabling is known the capacity of information that can transmit and which shall be according to the teams of each layer of the hierarchical network model.

#### Elements of structured cabling

The elements that make up the structured cabling are connected to a central point, which facilitates networking, System Administration and enables virtual communication between devices that make up the network at any time. It is necessary that the system complies with rules and standards, which are common and application-independent and to project long term.

Figure 6 shows some of the elements that make up a wiring system structured and how its distribution in a building.

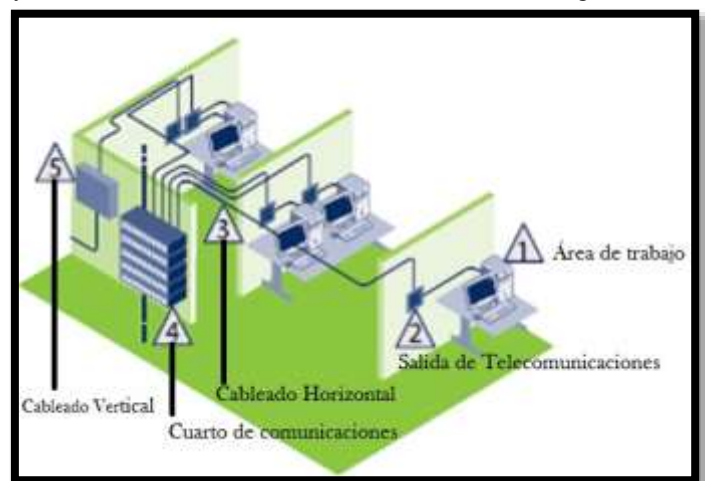


Figure 6. Elements of structured cabling  
Source: <http://goo.gl/cPIIp5>

The following are some elements that make up the structured cabling.

- **Work Area.** - Work area-is since the completion of the horizontal cabling to the computer where the user is located.
- **Cabinet of telecommunications.** - provide many different for cable system functions, are a separate subsystem but part of the hierarchical system wiring.
- **Equipment Room.** - is defined as the space where are located the common building telecommunications equipment. These teams may include telephone exchanges, computers (servers).
- **Backbone of campus.** - is the physical interconnection (wired or wireless) between two or more buildings.

#### Structured cabling standards

Currently the wiring standards used for the design of data networks structured have been established by the telecommunications industry association and the EIA and which are validated by the ANSI.

The standard ANSI/TIA/EIA-568 and recent updates specify the requirements of a comprehensive system of wiring, standalone applications and providers, for commercial buildings.

It is estimated that the productive life of a system for commercial buildings must be aged 15 to 25. In this period, telecommunications technologies will surely change several times. This is why the design of the wiring must have large bandwidths, and be suitable to current technologies and future. [4]


The latest published by the TIA standard is the ANSI/TIA/EIA 568-C. is a revision of the ANSI/TIA/EIA 568-B, published between 2001 and 2005. The new standard strengthens the core documents of the original recommendations and all the "addendum" (Category 6 Consortium, 2002)

*ANSI/TIA/EIA – 568-C.0*

It aims to allow the planning and installation of a wiring system structured generic that adapt to all types of installations. This standard determines a system that supports wired telecommunications in a multi-product and multi-vendor environment. Several of the concepts originally listed in the ANSI/TIA/EIA-568-B.1 recommendation (that was specific to commercial buildings) were widespread and included in the 568-C.0.

Set out in this recommendation as a structure of wiring should be designed in "Star", and defined a new nomenclature concerning the different stages or subsystems of the wiring. In table 2 refers to the elements that now make up the ANSI/TIA/EIA-568-C.0 standard, and in Figure 7, you can see how are distributed.

Table 1. Standard nomenclature ANSI/TIA 568C.0

| Nomenclature of the standard ANSI / TIA / EIA 568 C.0                               |                     |
|---|---------------------|
| Wiring segments   | Cabling Subsystem   |
| Connection points   | Distributor         |
| Distributor output  | Output Equipment    |
| Distributor C(DC) is the main cross-connect (MC).                                   |                     |
| Distributor B (DB) represents the intermediate cross-connect (IC).                  |                     |
| Distributor A (DA) represents the horizontal cross (HC) connection.                 |                     |
| The output device (EO) represents the telecommunications outlet and the plug.       |                     |
| Cabling Optional -----  |                     |
|  | Consolidation point |

Source: Based on Figure 7.

*ANSI/TIA – 568-C.1*

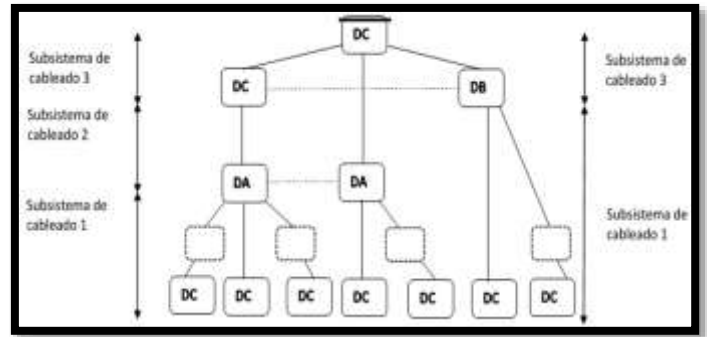


Figura 7. Elements of a generic structured cabling system Modified by Esmeralda Patiño

Provides information on the planning, installation and verification of wiring structured for commercial buildings. Aspects of the previous recommendation, ANSI/TIA/EIA-568-B.1 which apply only to this type of buildings were detailed and updated in this new recommendation. (Joskowicz, 2013, p. 30)

It is a standard that gives the ability to perform a set of structured wiring multi-manufacturer and multiproduct, standard is also compatible with applications such as voice, data and video.

The standard ANSI/TIA 568 - C.1 replaces the ANSI/TIA/EIA-568-B.1 and its addenda. The differences can be noticed are:

- Wiring system includes structured recognized Category 6A.
- Includes 850nm 50/125um multi-mode fiber optic wiring.
- 500 ohm and 75 Ohm coaxial wiring STP of 150 ohms, the cabling category 5 cabling is no longer media recognized.

*ANSI/TIA – 568-C.2*

The objective of this standard is to specify the cable and components for balanced twisted pair copper category 3, category 5E, category 6 cable and Category 6A. (Guambuquete, 2012, p. 4)

It details the specific requirements of wires in pairs braided balanced, at the level of its components and its transmission parameters.

The recognized categories are:

- **Category 3.** - wire UTP 100 ohm and components up to 16 MHz of bandwidth.
- **Category 5e.** - UTP cable of 100 ohms and components up to 100 MHz of bandwidth.
- **Category 6.** - Cable UTP 100 ohm and components of up to 250 MHz of bandwidth.
- **Category 6A.** - Cable UTP 100 ohm and components up to 500 MHz of bandwidth. It complies with the requirements of alien crosstalk to support 10GBASE-t transmission systems.

#### *ANSI/TIA – 569-A*

"The standard for travels and telecommunications space in commercial buildings specifies design and construction inside buildings and between them, practices that support equipment and means of telecommunications." (Gonzalez F., 2008, p. 55)

The present edition of this standard is of February 1998 implies (González F., 2008, p. 55), then the elements for tours of telecommunications in buildings and spaces:

- Horizontal trips
- Closets of Telecommunications
- Trips for Backbones.
- Room of Teams
- Workstation
- Room of Entry of Services

#### *ANSI/TIA – 606-A*

Specific management for telecommunications infrastructure in commercial buildings includes standards for the labeling of wiring and termination of hardware each must have a unique identification. It also describes requirements for records and maintenance of documentation for the administration of the network. (Gonzalez F., 2008, p. 60)

The ANSI/TIA/EIA-606-A standard replaces the earlier ANSI/TIA/EIA-606 originally published in August 1993. This version was approved in May 2002. This new version specifies four kinds of management systems for a range of telecommunications infrastructure which are and are detailed in: (Gonzalez H., 2008, p. 61)

- **Class1.** - It is for simple buildings that are served from a single room equipment.
- **Class2.** - It is for simple buildings with an equipment room and several quarters of telecommunications.
- **Class3.** - It is campus with several interconnected buildings.
- **Class4.** - It is for multicampus environments.

#### *TIA/EIA TSB-67*

It is an addendum to specific for testing in the field of the transmission performance of unshielded twisted pair cabling systems.

This technical bulletin (TSB) telecommunications is defined specifications and forms for validation and certification of structured cabling (field testing) post-install. The specifications include electrical characteristics of testing field, test methods and minimum requirements for the transmission of UTP cabling systems. TIA/EIA TSB-67 refers to two configurations of verification by basic link or channel and permanent link.

#### *Datacenter*

A Data center or data centre is a space or portion of a building where companies and public and private institutions protect, operate and store the ICT infrastructure used to manage and administer your business. It is the physical space where host servers and storage equipment running the applications, services and processed and stored data and content that the company provides to its customers.

Data Centers are based on international norms and standards to ensure its performance and security in the handling of the information, according to the standards IEEE 802.3 and ANSI/TIA-942 infrastructure in support of a data center must be composed of four sub systems such as it, telecommunications, architecture, electrical and mechanical system. (Cabrera, 2013, p. 21)

A data center can store lots of information of all kinds, as well as financial institutions, institutional emails information are saved.

Among the main objects that must have a datacenter are: alarm system with sensors of movement and latest technology electronic locks, allow the entry of authorized personnel, the temperature control enables teams to operate at full capacity. Electric generators in case of power failure, fire camcorders and safety cabinet's detection systems form part of the basic equipment required on international standards to run a data center. (Costal Rivera, 2015)

#### *Estándar TIA/EIA 942*

This standard specifies the minimum requirements for the infrastructure of telecommunications in a datacenter. It was originally published in 2005, but the latest update was published in April 2013. In general, the TIA-942 considers the following aspects: (Ponce, Durán, and Davila, 2013, p. 11)

- Design and spaces of the sites
- Cabling infrastructure
- Levels of reliability
- Environmental considerations

On the other hand the infrastructure support of a data center is divided into four subsystems.

**Telecommunications.** - Wiring cabinets and horizontal, redundant access, entry, area of distribution, backbone, active elements and redundant power, patch panels and patch cords, documentation.

**Architecture.**- selection of location, type of construction, fire protection and requirements NFPA<sup>2</sup> 75, vapour barriers,

<sup>2</sup> NFPA: National Fire Protection Association – Asociación Nacional de Protección contra Incendios



ceilings and floors, office areas, rooms of UPS<sup>3</sup> and batteries, room of generator, access control CCTV<sup>4</sup>, NOC<sup>5</sup>.

**Electrical system.** - Number of accesses, points of failure, loads criticism, redundancy of UPS and topology of UPS, grounded, EPO<sup>6</sup> batteries, monitoring, generators and transfer systems.

**System Mechanic.** - Air conditioning, positive pressure, pipes and drains.

Another part of the standard also mentions a data center must include functional areas:

- One or more entrances to the Center
- Main distribution area.
- One or several areas of distribution.
- Horizontal distribution areas.
- Area of distribution equipment.
- Distribution area
- Wiring Horizontal and backbone.

The standard ANSI/TIA 942 2005 annex of 1 to 4, includes four levels of availability called TIER they differs in the level of availability of the data center.

#### D. IPAddressing

The IP address is a number that identifies a logical and hierarchical manner to a host is unique within a network that uses IP protocol. This protocol uses numeric address called addresses composed of four (4-byte) integers between 0 and 255, and written in the format xxx.xxx.xxx.xxx. For example, 172.140.34.67 is an IP address in technical format.

#### IPv4

The definition for the IP protocol is in RFC 791, in which data transmission is based on the Internet. The IPv4 address is represented by 32-bit binary, which are four octets separated by a point. It has these parts is identified as the network to which belongs the host and also identifies the host within a network depending on the class.

Classes which is divided into an IPv4 are three IP addresses that is assigned by the authority for allocation of numbers Internet (IANA) worldwide: class A, class B, and class C. Currently, IANA reserve class A addresses for Governments around the world and addresses of class B for medium-sized companies. Class C addresses are granted to all other applicants. Each kind of network allows a fixed number of computers (hosts).

The number of unique addresses available using IPv4 is 2<sup>32</sup> which is roughly 4.3 billion possible combinations. Currently this number even though it seems a large number of addresses has been exhausted since there are addresses that are reserved and others are assigned to the devices, which are becoming more and more which are connected to the network.

#### IPv6

The IPv6 (Internet Protocol, version 6) was created to resolve the crisis posed by the depletion of IPv4. To represent the addresses, uses 128-bit, which generates a space equivalent to about 340 undecillones or, in mathematical terms, more than 7.9 x 10<sup>28</sup> times higher than the number of IPv4 addresses. As for IPv4, the body responsible for managing addresses is the RIR and IANA.

Addressing in IPv6 made it so, for this was a notation in which 128 bits have been divided into eight blocks of 16 bits, separated by the symbol ":", where each block is represented by 4 hexadecimal digits. (Solis & cow, 2014, p. 39)

IPv6 addresses are not assigned to nodes, but to the individual interfaces on nodes; in this way a single interface can represent multiple unique addresses and any of the addresses associated with the interface of a node, can be used to identify uniquely to that node. (Solis & Vaca, 2014, pág. 39)

#### Transition Mechanisms

The transition from IPv4 to IPv6 is being gradually until then the two protocols should coexist and provide a smooth transition within an organization. For the transition, we will need a process where the first step will be the phase of "double stack" where the two protocols will coexist on the servers of the company to then be gradually changing.

### III. ANALYSIS OF THE INFRASTRUCTURE EXISTING OF THE DATA NETWORK OF THE COOPERATIVA DE AHORRO Y CRÉDITO SAN ANTONIO LTDA.

#### A. Identification of the number of areas and users

The company has a matrix of 2 storey building, each floor has its areas of work already defined by the company, each section or area is divided by its importance and service offering for partners in two plants, in the following table 2 and figures 8 and 9 listed areas and the floor where each.

Table 2. Área floor

| Floor     | THE COMPANY SECTION AND NUMBER OF USERS |   |
|-----------|---|---|
| Low Level | Information                             | 1 |
|           | Checkouts                               | 3 |
|           | Credit                                  | 3 |
|           | Operating Assistant                     | 2 |
|           | Assistant portfolio                     | 2 |
|           | Investments                             | 1 |
| Top Floor | General Management                      | 1 |
|           | Secretary                               | 1 |
|           | Human Talent                            | 1 |

<sup>3</sup>UPS: Uninterrupted power system

<sup>4</sup>CCTV: Closed circuit Television

<sup>5</sup>NOC: Network Operation Center

<sup>6</sup>EPO: Optional emergency shutdown function

|                     |   |
|---------------------|---|
| Presidencia         | 1 |
| Auditoría Interna   | 1 |
| Crédito y Cobranzas | 1 |
| Contabilidad        | 1 |
| Sistemas            | 2 |
| Riesgos             | 1 |
| Sala de reuniones   | 1 |

**Source:** Closed circuit Television of the Cooperativa de Ahorro y Crédito San Antonio de Ibarra



Figure 8. Distribution of areas low silver  
Source: Graphic in Microsoft Visio 2013 by Esmeralda Patiño



Figure 9. Distribution of areas upstairs  
Fuente: Graphic in Microsoft Visio 2013 by Esmeralda Patiño

### B. The current network topology

The cooperative network is a topology completely flat, this says that all network devices (cameras, servers, printers, telephones, computers, etc...) are connected to a switch, this switch and transmits information between devices that want to communicate, there is a hierarchy where at the top are the servers.

Figure 22 shows the current distribution of the internal data network of the cooperative, as well as active teams that connect network devices.

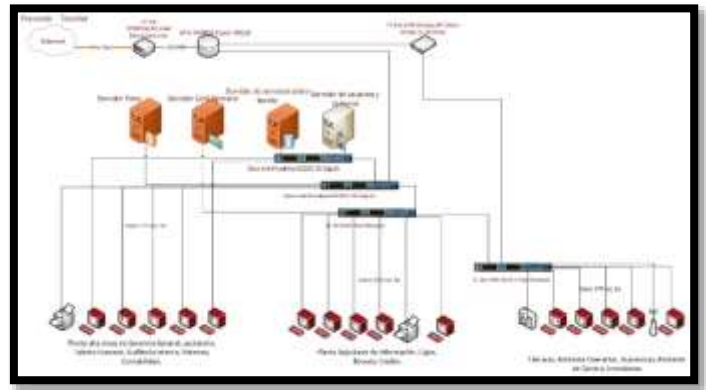


Figure 10. Physical topology of the Cooperativa de Ahorro y Crédito San Antonio  
Source: Graphic in Microsoft Visio 2013 by Esmeralda Patiño

### C. Structured Wiring

The network cabling is a very important part to provide more and better services to members, this is why you must be in the correct state. For this will be discussed several points of importance such as: horizontal subsystem, vertical subsystem, equipment room and workspaces.

#### Horizontal Subsystem

The parent building has a horizontal cabling in the ground floor is UTP cable cat. 5E with approximately 8 years of use and on the second floor about 4 year's cat. 6, the distribution to the areas of work is done through the false ceiling with metal trays.

The structured cabling of the ground floor is the floor with corrugated tube and decorative adapted gutters, while the second floor is the walls corrugated plastic tubing is used. Gutters with category 6 cable is used for growth of the network.



Figure 11. Channelling of cables  
Picture taken on the premises of the matrix San Antonio by Esmeralda Patiño

### D. IP Addressing

The IP addressing of the Cooperativa de Ahorro y Credito San Antonio is assigned statically, there with VLAN's, below are IP addresses of matrix and its links to branches.

Tabla 3. Addressing of the Cooperativa de Ahorro y Crédito San Antonio de Ibarra

| Location  | Net/Mask         | Addressing of host                | Gateway        |
|-----------|------------------|-----------------------------------|----------------|
| Matriz    | 192.100.100.0/24 | 192.100.100.1-<br>192.100.100.254 | 192.100.100.91 |
| Ibarra    | 192.100.102.0/24 | 192.100.102.1-<br>192.100.102.254 | 192.100.100.91 |
| Atuntaqui | 192.100.101.0/24 | 192.100.101.1-<br>192.100.101.254 | 192.100.100.91 |

Source: Data provided by the Department of systems

Table 4. IP addresses of the servers

| SERVIDOR/HOST                     | Addresses IP       |
|-----------------------------------|--------------------|
| ServerCore Bancario               | 192.100.100.57/24  |
| Server of services cobro facilito | 192.100.100.100/24 |
| Server of camera and users        | 192.100.100.11/24  |
| Server Proxy                      | 192.100.100.91/24  |

Source: Data provided by the Department of systems

#### IP addressing of the links

Below are the addresses IP links to branches provided by TELCONET see Figure 11.

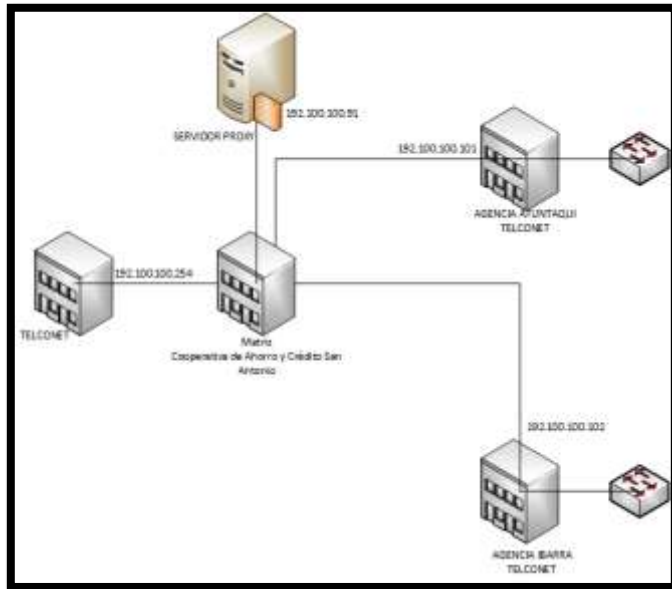


Figure 12. IP addressing of the links

Source: Data provided by the Department of systems by Esmeralda Patiño

Addressing configuration is property of TELCONET router, the cooperative has to connect with branch offices of links to 1024 Kbps for Ibarra to Atuntaqui, in the hub are 2048 Kbps.

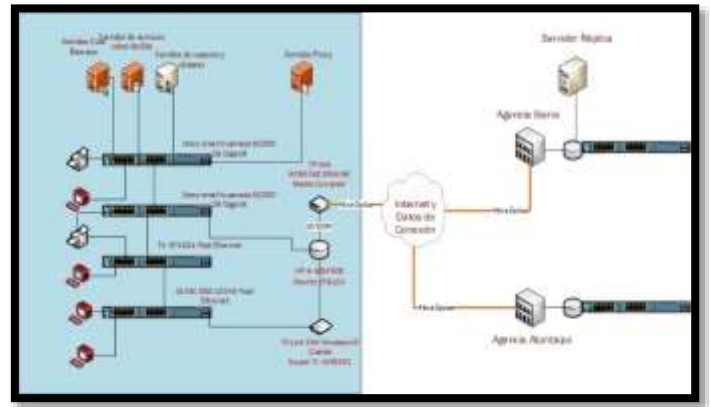


Figure 13. Physical topology of links with branches

Source: Picture Microsoft Visio 2013 by Esmeralda Patiño

## IV. REENGINEERING OF INTERNAL DATA AND DESIGN OF THE WIRELESS INFRASTRUCTURE TO YOUR BRANCHES.

### Requirements analysis

For the reengineering of the internal infrastructure of the Cooperativa de Ahorro y Credito San Antonio Ltda., on base layers model is necessary to examine the data as network requirements: number of departments, users, and applications to manage.

### Number of departments and users

Section 2.3 noted the current distribution of the departments of the cooperative and number of users, now we will classify it according to the requirements within the institution structured cabling.

### Proposal and considerations to improve the structured cabling

The design of structured cabling is very important in a network of data and so must comply with standards such as ANSI/TIA/EIA 568-C.0, ANSI/TIA/EIA 568-C.1, ANSI/TIA/EIA 568-C.2, ANSI/TIA/EIA 569-A, ANSI/TIA/EIA 606-A, to access current technologies growth of 5 years and changes in the data network.

Below is a proposal to improve the structured cabling of data network.

To carry out the proposal of structured wiring has taken into consideration two fundamental aspects.

1. The certifications of the points of the network in accordance with the TSB-67 bulletin.
2. The construction of the building and installed nowadays network wiring.

Currently horizontal on the second floor and part of the ground floor of the building wiring is Gigabit Ethernet network with UTP CAT 6 cable with speeds of 1Gbps and maximum distance of 100 metres and taking into account the throughput of the network can manifest that the transmission medium is valid and that it supports data services voice and video.



It should be noted that the part of the building which has 5e cable should be replaced by UTP Cat. 6 so the network is consolidated in addition to the proposed new units handle speeds of 10/100/1000.

Therefore to maintain across the network using a UTP cabling category 6 support that new equipment and wiring are used to their maximum speed by 10/100/100 end users taking into account that the level of utilization is low and there is no need for higher speeds. Have a life time equal to the entire building.

The standard ANSI/TIA/EIA - 568-C.2 recognizes the UTP cable cat. 5E and 6 maximum distance from the rack up to the faceplate of the work area is about 27 meters in our building.

*Cabling Horizontal*

This wiring goes from the connectors on the work area to the rack in the equipment room. A type topology star is set to have a better management in the future implementation of services and that there are no disadvantages.

An important point to be taken into account for the growth of network points is the projection to the future of the network. The maximum allowable distance for horizontal wiring that sets the standard is 100 meters.

The standard ANSI/TIA/EIA - 568-C.2 contains several points which must be taken into account to improve the network wiring.

- The maximum length of the patch cord to connect the patch panel network teams is maximum 5 meters.
- The patch cord that connect telecommunications output to a printer, computer, or phone is 5 meters.
- Do not can exist more than one crossover point and a point of consolidation between the rack and the output of telecommunications, there be joints, bridges and derivations
- All connections new horizontal wiring must be documented and tagged, recently added points must be labeled.

*Tagging*

The tagging will take place according to the ANSI/TIA-606-A management standard for the telecommunications infrastructure of commercial buildings where recommended fashion label. Labels should be sticky and auto-laminadas to be protected against any damage or erases, also identification will be the same as the patch panel of the rack using the box.

**New labeling proposal**

- Floor to which belongs the point.

|             |    |
|-------------|----|
| Planta baja | PB |
| Primer Piso | PP |

- Identification of the patch panel.

|                  |   |
|------------------|---|
|                  |   |
| Patch Panel Dos  | 2 |
| Patch Panel Tres | 3 |

|                    |   |
|--------------------|---|
| Patch Panel Cuatro | 4 |
| Patch Panel Cinco  | 5 |

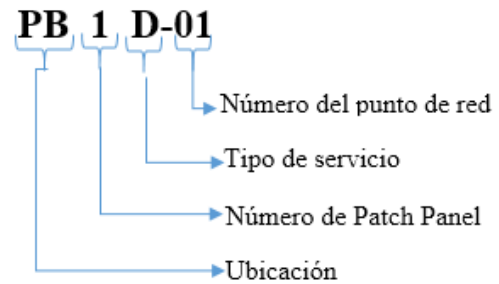
- Type of service.

|            |   |
|------------|---|
| Voz        | V |
| Datos      | D |
| Servidor   | S |
| Cámaras    | C |
| Impresoras | I |

- The point of network number.

It identifies the point of network depending on your location in the patch panel and in the output of the network make it possible point.

Sample:



This point corresponds to the ground floor - patch panel one - type of service data - point 01 number.

*Vertical cabling*

In the study it was found that you there is vertical wiring, all teams are in the equipment room, from here comes out the horizontal cabling is the maximum distance that is 26.518 meters. The standard ANSI/TIA-568-C.1 recommended topology must be type star. On the other hand will not be vertical cabling since last remodeling teams were brought to the floor that it did not have space or place for the teams on the ground floor and held a space especially to keep the equipment room on the top floor.

*Door Equipments*

Considerations taken from the standard EIA/TIA 942, which must be taken into account for the proper functioning of the equipment room:

- Use anti-static paint for floor area that comprises the equipment room, also prevents detachment of powder for cement and thus does not cause damage to the equipment.
- The UPS is made up of 16 battery - 6kva an electric generator wave for network UPS and breakers of protection.
- Air conditioning: Mark LG precision to maintain a temperature between 18 and 24 degrees Celsius.
- Security: install a security door in the access to the computers by using a biometric control system.
- Having clean-agent fire system (ecological extinction system non-toxic).
- There must be a constant maintenance of the equipment room since the dust or debris damaged equipment.

- The standard TIA 942 is recommended that the office of the operator against the fourth team.

Since the UPS of the cooperative has been constant damage was an estimate of the capacity of the UPS required based on the characteristics of the equipment.

**Table 5** Calculation of the required UPS.

| DESCRIPCIÓN DEL EQUIPO | NÚMERO DE EQUIPOS | VOLTAJE (V) c/u | WATIOS (W) c/u | INTENSIDAD I=W/V c/u | PICO POTENCIA (40% más de W) c/u | Total potencia |
|------------------------|-------------------|-----------------|----------------|----------------------|----------------------------------|----------------|
| computadores           | 25                | 120             | 240            | 2                    | 336                              | 8400           |
| servidores             | 5                 | 120             | 460            | 3,83                 | 644                              | 3220           |
| switches               | 4                 | 120             | 150            | 1,25                 | 210                              | 840            |
| router                 | 2                 | 120             | 80             | 0,67                 | 112                              | 224            |
| impresoras             | 5                 | 120             | 200            | 1,67                 | 280                              | 1400           |
| cámaras ip             | 11                | 120             | 25             | 0,21                 | 35                               | 385            |
| <b>TOTAL</b>           |                   |                 |                |                      |                                  | <b>14469 w</b> |

Source: Data were obtained from the characteristics of each team and consulted in <http://bibdigital.epn.edu.ec/handle/15000/4460>

The current UPS which has the cooperative is 6kVA - 4200w. According to calculations the UPS should be 15Kw to support equipment described in table 5.

*Hierarchical network model*

The chosen network model to perform internal data infrastructure reengineering is the hierarchical since it allows future growth, management, and convergence of voice and data.

For the calculation of the number of teams from each layer takes into account the number of points on each floor, functionality and capacity that will occupy each team, for the capacity retrieved traffic is taken into account.

*Access Layer*

It is the layer that is responsible for the connection with end users, printers, ip cameras, ip phones. The calculation of the number of switch for this layer depends on the points of the cooperative network and the characteristics of the network traffic. At this level, issues will be handled as port, VLAN security.

In the cooperative does not exist a defined network model so there are just four switches layer L2, 2 manageable via Web and not manageable 2 but which meet the need of the current network points. The four switches are located in the equipment room.

**Number of switches by layer access**

With the following formula determines the number of layer switches access.

$$\text{Número de switches de acceso} = \text{Entero Superior} \left[ \frac{\text{Total de puertos de red}}{\text{Número de puertos de usuario final por switch}} \right]$$

Switches having the cooperative currently have 24 ports for each switch.

$$\begin{aligned} & (\text{Número de switches}) \cdot (\text{de acceso}) \\ & = \text{Entero Superior} \left[ \frac{65 \text{ puertos de red}}{24 \text{ puertos de usuario final por switch}} \right] \\ & \text{Número de switches de acceso} = 3 \text{ switch de acceso} \end{aligned}$$

With the above formula determined the number of total access switches, the calculated by the number of points of data and telephony.

As data traffic analysed with the NTOP tool and detailed in section 3.4.7 is that total traffic during a day is 307.2Mbytes end users access switches port speeds supported are:

$$\text{Velocidad de puerto de usuarios final} = 10/100/1000 \text{ para conexión con las estaciones de trabajo}$$

Therefore the model requires 3 switches from access with a speed of 10/100/1000Mbps ports.

*Distribution Layer*

This layer is responsible for security policies for access to services, routing between the VLAN's and communication with the layer of Core; for the calculation of the number of switch of this layer is used the traffic that comes from access to the network layer uses two switch L3 layer that connects all the layer switch access.

It is important that this layer is handled a team with good features like a team of L3 layer, below are the necessary calculations to determine the number of ports that are required for the connection to the switching capacity for ports.

$$\begin{aligned} & ((\text{Número de puertos}) \cdot (\text{requeridos para})) \cdot ((\text{cada switch de}) \cdot (\text{distribución})) \\ & = ((\text{Número de puertos para enlaces}) \cdot (\text{con los switches de acceso})) \\ & + ((\text{Número de puertos para conexión}) \cdot (\text{con los switches de núcleo})) \\ & + ((\text{Número de puertos para}) \cdot ((\text{interconexión entre switches}) \cdot (\text{de distribución}))) \\ & + ((\text{Número de puertos}) \cdot (\text{respaldo})) \end{aligned}$$

$$\begin{aligned} & \text{Número de puertos requeridos para cada switch de distribución} \\ & = (3) + (2) + (1) + (6) = 12 \end{aligned}$$

$$\text{Capacidad de conmutación para los puertos en full duplex} = 2 \left( \frac{\text{Número de puertos requeridos}}{\text{requeridos}} \right) \times (1Gbps)$$

$$\text{Capacidad de conmutación para los puertos en full duplex} = 2(12) \times (1Gbps)$$

$$\text{Capacidad de conmutación para los puertos en full duplex} = 24Gbps$$

*Security Politics/Access control lists*

In the layer distribution an important point that is managed is security, Union and credit San Antonio Ltda., handles some security on the basis of these policies shall be based the ACLs (Access Control lists) and safety of port as a security level.

Some of the security policies that are shown below were given by the Department of systems of the institution, these were mostly modified and improved based on the vulnerabilities and risks observed in the physical and logical data network. In addition to that should guarantee the security of data and assets of the financial institution.

## V. COST – BENEFIT ANALYSIS

This budget is presented for a future implementation of hierarchical network model of three layers, also presents the cost of equipment for the wireless link. Prices are referential and have been taken from the preform requested two national companies. To the table with the referential prices.

Table 6. Reference prices for the model of network and wireless network.

| ITEM  | RUBRO  | CANTIDAD   | PRECIO UNITARIO | PRECIO TOTAL   |
|---|--|------------|-----------------|----------------|
| <b>CABLEADO ESTRUCTURADO</b>                                |  |            |                 |                |
| 1   | Patch Cord UTP Cat.6 3ft                                 | 50         | 9,75            | 487,50         |
| 2   | Certificación  | 48         | 7,00            | 336,00         |
| 3   | Mano de obra   | 15 (Horas) | 20,00           | 300,00         |
| 4   | Lote de etiquetas(30 puntos)                             | 7          | 3,60            | 25,20          |
| 5   | Accesorios (RJ-45, tornillos, amarras)                   |            |                 | 10,00          |
| <b>TOTAL 1</b>  |  |            |                 | <b>1158,70</b> |
| <b>EQUIPOS DE CONECTIVIDAD: SWITCHES ENLACE INALÁMBRICO</b> |  |            |                 |                |
| 6   | Cisco CISCO SMB SRW224G4-K9-NA                           | 4          | 366,60          | 1466,40        |
| 7   | Cisco Sg200-26p Switch Gigabit 24 Puertos + 2 Spf Capa 2 | 2          | 175,99          | 351,98         |
| 8   | MIKROTIK ROUTER BOARD SXT 5HPnD                          | 2          | 259,99          | 519,98         |
| 9   | MIKROTIK ROUTER BOARD OMNITIK U-5HnD                     | 3          | 149,99          | 449,97         |
| 10  | Configuración e Instalación de equipos                   |            |                 | 1000,00        |
| 11  | Mantenimiento (24 veces/año)                             |            |                 | 480,00         |
| 12  | Transporte, impresiones, Varios                          |            |                 | 200,00         |
| <b>TOTAL 2</b>  |  |            |                 | <b>4468,33</b> |
| <b>TOTAL=TOTAL 1 + TOTAL 2</b>                              |  |            |                 | <b>5627,03</b> |

**Source:** Prices were taken from the following pages: <http://goo.gl/3CYnC9>, <http://goo.gl/j6oJZt> and the proforma requested from each company.

The number of patch cord were calculated based on the number of links and connections of the new layer L3 and L2 layer switch taking into account the existence of patch cords and cable UTP cat. 6 that exists in the cooperative. The cost of the UPS is not took into account since he was in the process of change.

The costs of maintenance will be held whenever the cooperative maintenance requests it with a maximum per year of 24 times consists of updates, queries and configuration.

### *Analisis Cost- Benefit*

(Kendall & Kendall, 2013) tells us that the benefits and costs can be represented as tangible or intangible. Benefits and

tangible and intangible costs must take into account when considering systems.

To give a result of our benefit analysis we will start analyzing the costs of future implementation, taking into account the referential budget presented.

### **Cost Analysis**

In the cost analysis will take into account factors such as investment for equipment and materials costs, costs of configuration of equipment and maintenance costs. The purchase of active equipment, is necessary because it ensures the functioning of the hierarchical network model and wireless links.

### **Configuration and installation equipment costs**

These costs are the values for labor for hours of connection of cabling, configuration, report and active equipment (Switches) and it is the transportation, certifications, and impressions.

### **Maintenance costs**

Maintenance costs are values-related receivables in respect of updates, new configurations and technical support of the active teams.

### **Analysis of Benefits**

For the analysis of the benefits is should take into account revenues to the cooperative within a period of time, which, for our calculation is of 5 years which is the estimated time of active equipment depreciation but were not provided since they are confidential, so it will be an analysis of intangible benefits described in the improvement of the quality and productivity of users and members of the Cooperativa.

Are then drafted the benefits that will bring the reengineering of the network based on the application of the hierarchical network model in the Cooperativa de Ahorro y Credito San Antonio Ltda.

- Starting from what evident before the reengineering is was obtained several benefits especially for the systems Department Administration will be handled by that being more predictable to any failure, the network will grow at any time and without complications.
- To have redundancy of equipment ensures the availability of information, increases the accuracy being more competitive with the service the customer maintaining a good image of the cooperativa.
- Increases the satisfaction of users having network availability by eliminating waits and tasks of the Department's systems to go to find the problem.
- Ensure the information on the co-operative is vitally important so make technological change help to security at ports as well as the settings of access list that is a level of security.
- Maintaining quality information through ICT investment is a primary function of the authorities of the cooperative since they are subject to regulatory agencies such as the LOSEP, this is of benefit from the cooperative to re-engineering and investment so that support to current and future needs.

- In a blog published by 2014 (Sanchez) declares that "the companies that survive are which assume technological change"
- (Kendall & Kendall, 2013), says that "the intangible benefits of a technological change are important factors that should be considered in deciding to make the reengineering of the LAN"

## CONCLUSIONS

The study of the basic concepts for the reengineering of the data network helped to know the shortcomings of the LAN network and also to establish a network model that improves the errors found.

The information obtained at the analysis of the current situation of the network of the Cooperativa de Ahorro y Credito San Antonio allowed to demonstrate more thoroughly on the vulnerabilities and flaws like the lack of a model that structure the network correctly.

To make the certifications of data points was observed shortcomings that had not been detected with the naked eye, such as labeling failures, data connected to rack points but that has been removed by remodeling, this allowed to determine the flaws in the structured cabling.

The development of reengineering based on analysis allowed the cooperative provide a hierarchical network model which allows an ordering of data network based on layers with specific in each functionality with results such as availability, scalability, and security of the data network.

The information handled by the cooperative is vitally important for this reason both cabling as teams that routed the information should be in optimal conditions so that in the proposed network model provide the assurances that are established for each layer such as access control lists and port-level security.

To analyze the network traffic problems of broadcast was found to solve this problem was the segmentation of the network VLAN's based on features and requirements of each Department of the cooperative.

Learn about the features and requirements of each department allowed perform the vlan's with the network address in IPv4 and perform a configuration to future of the application of a dual-stack transition mechanism in layers of core and distribution as a first step to migrate to IPv6.

Based on the new standards for wiring structured ANSI/TIA/EIA 568.C and hierarchical network model a proposal the structured cabling of data network, where mainly applies new labeling of points which will recognize where the data point both in the rack stations work and recommendations for equipment with standard TIA/EIA 942 nursery belongs.

To determine the number of computers access layer assets was taken into account the number of users by each Department, printers, phones and cameras for the layer distribution and core was taken in account the redundancy that is needed in the network, in addition to calculations were performed to determine the capabilities required.

As it's a reengineering in that the first point is the reuse of computers that are in accordance with the hierarchical network model was carried out an analysis of the characteristics of teams where re-use of two layer teams determined access.

The choice of coating equipment core and distribution was carried out a comparison of two brands in the domestic market and thus determine the best in base criteria as ease for the user in the management of the team and management of the network, the network administrator already familiar with different configurations of the same and prices.

To determine the wireless link teams discussed aspects such as calculations of necessary bandwidth for the transmission of financial applications, Fresnel zones, distances and frequencies.

With the introduction of the referential budget, benefit cost analysis and model simulation, demonstrates the functionality and the need for cooperative implementation of hierarchical network model.

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