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FACULTAD DE INGENIERÍA EN CIENCIAS APLICADAS

CARRERA DE INGENIERÍA EN ELECTRÓNICA Y REDES DE COMUNICACIÓN

SCIENTIFIC REPORT

THEME:

DESIGN OF A NETWORK OF ACCESS FTTB (FIBER TO THE BUILDING) TO INTERCONNECT 8 UNITS OF GOVERNMENT DECENTRALIZED AUTONOMOUS MUNICIPAL DE OTAVALO

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Design of a network of access FTTB (fiber to the building) to interconnect 8 units of Government Decentralized Autonomous Municipal de Otavalo (April 2016)

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Summary- *The present project will interconectar 8 Municipal offices belonging to the Government Decentralized Autonomous Municipal de Otavalo, through a network of access FTTB (Fiber to the building) of fiber optics, based in transmission technology GPON, has been made with the main objective to optimize the network and with the passage of time unify services, enabling citizens to have access to all municipal services in the 8 dependencies*.

Index Terms-DMZ, IDS/IPS, UTM

I. INTRODUCTION

Need to stay in touch and be able to exchange information quickly and safely, it is one of the greatest challenges that are faced with daily. As time passes and users increase their demands to the communications network, for which they require higher capacity links, the same that are obtained by increasing the bandwidth, through the use of higher frequencies reflected in the implementation of a routing of copper, or deploying more repeaters for radio links.

II. GENERAL ANALYSIS

At present the optical fiber is considered as the main means of transmission of information at the global level with regard to telecommunications. This is possible thanks to their optical performance that since its inception has been carrying large amounts of data through the light.

A. Optical Fiber

The optical fiber is defined as a means of transmission used at present to implement data networks, consists in a fine wire that can be made of materials such as glass or plastic, for which travel light pulses generated by a laser or an LED.

1) Advantages

Bandwidth. - Communications systems based on fiber optics have greater capacity to transport information.

Noise Immunity. - provides immunity to interference caused by lightning, electric motors, etc.

Electromagnetic interference - Systems have an immunity to cables that are contiguous and that can create a magnetic field.

Weight. - The optical fiber as such in comparison to a copper conductor is relatively light so it is an advantage due to that facilitates the technician to operate with ease.

Temperature. - an important factor because it is manufactured to high temperatures, tolerates temperatures approximately (-55°C - 85°C), for this reason ensures the resistance to heat and cold. (Beltrán, 2015). Significantly reduces the risk of causing fires in comparison to the copper conductors.

2) Singlemode fiber optic

The diameter of the core of the fiber is very small and only allows the propagation of a single mode or lightning (root), which spreads directly without reflection. This effect causes your bandwidth is very high, so that its use is generally reserved to great distances, above 10 km, together with devices of high cost (laser). (OPTRAL, 2015)

3) Multimode Optical Fiber

Multimode said that many light rays travel in many ways, each of which follows a different path within the optical fiber. This effect makes your bandwidth is lower than that of single mode fibers. On the contrary, the devices used with the Multimode have a lower cost (LED). This type of fiber are preferred for communications in small distances, up to 10 Km. (OPTRAL, 2015)

B. *Passive Optical Network (PON)*

A passive optical network (PON Passive Optical Network) enables you to delete all the existing active components between the server and the customer by entering in your place optical components liabilities (optical dividers liabilities) to guide the traffic across the network, whose main element is the device optical divider (known as splitter). (Jain, 2011).

TABLE 1
MAIN FEATURES OF TECHNOLOGIES PUT

Features	APON	BPON	GPON
Transmission Rate (Mbps)	1250 (symmetrical mode)	Lowered: 1244; 622; 155 Lift: 622; 155	Lowered: 2488; 1244 Lift: 2488; 1244; 622; 155
Line encoding	8B/10B	NRZ	NRZ
Maximum number of subscribers by fiber optics	32	32	64
Maximum Reach (km)	20	20	60
Standardization	IEEE 802.3ah	ITU-T G983.x	ITU-T G984.x
Cost of implementation	The lowest of all	Less than GPON	Middle

*Note table adapted. Source: Manual of fiber-optic networks (2014), Ing. Juan P. Beltran

C. *Elements of a network PON*

1) *OLT (optical line terminal).-* is located at node of the service provider, provides the interface between the Pon and the network services of the provider
2) *Nla (optical distribution network).-* usually refers to the NLA as the different existing optical elements between the OLT and the different ONTs/ONUs of the GPON network. Usually consists of the different optical fibers and of the splitters required to diversify the network.
3) *Un (Optical Network Unit).-* The UN is one of the elements that can be registered against a OLT. In this case it is a question of distribution devices that provide service to more than one user.
4) *ONT (Optical Network Terminal).-* Located on the end user ends the passive optical network and presents the different services to the user.

D. *FTTX technology*

A network of access FTTX is not more than a network of distribution based on the deployment of fiber optic cable that reaches distances certain depending on the standard or the application you are currently performing.

In order to supply broadband services to end users, in places where remotely is difficult to reach with xDSL technologies, by limitations of technical aspect in terms of conditions of operation, arises the idea of bringing the nodes to homes, multiple units and small businesses that became common to the term; Fiber to the x (Fttx, fiber toward).

Between the acronyms used in the technical and commercial literature are the following same as shown in Figure 1:

- (FTTH fiber to the home)
- FTTC (fiber to the pavement)
- FTTC ab (fiber until the cabinet)
- FTTN (fiber until the Neighborhood)
- FTTB (fiber until the building)

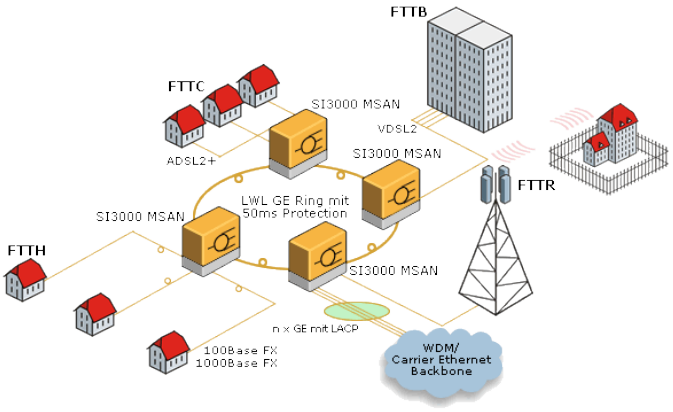

Figure 1: Optical Technologies
Source: Itm-Group, factor4 GMDS Germany GmbH. Retrieved from: http://www.itm-group.com/web/fttx-konzepte.html

III. ACCESS NETWORK DESIGN FTTB (FIBER-TO-THE-BUILDING) FOR THE GAD OF OTAVALO.

To carry out the design of the access network FTTB defines the geographical location of the units

which help the deployment of fiber optic cable through the streets of the city and goes to be aerial or underground all this will depend on the geography and situation of the city, this will help the choice of the type of fiber.

According to the specifications of the technology, we choose the equipment that is used for the OLT, NLA and the UN parties required for the design of the network connection access to each unit in the same way is a description of the parameters of transmission in terms of attenuation and bandwidth required between the different units, number of current and projected users, the applications and services that are intended to provide.

A. Current Situation

The Otavalo Municipal GAD at present account with a carrier of prestige as is the National Telecommunications Corporation (CNT) of the Province of Imbabura. The GAD Otavalo Municipal has until now 4 data links with mentioned telecommunications company hired different plans as shown in Figure 3 1.

For these optical links is used the singlemode optical cable of 6 fiber yarns channelled ADSS G.652D, the same that allows high transmission speeds of both UP/DOWN simultaneously.

The 6 wire channelled that arrive from the supplier are distributed through a ODF G. G55/C of 6 wires - TERMINATION FC - PC front-opening. This form is used one of the threads that is directly connected to a converter that is responsible for transforming the optical signal to electrical, which is then connected to a Cisco router series 800, the same that disseminates the data to all segments of the network.

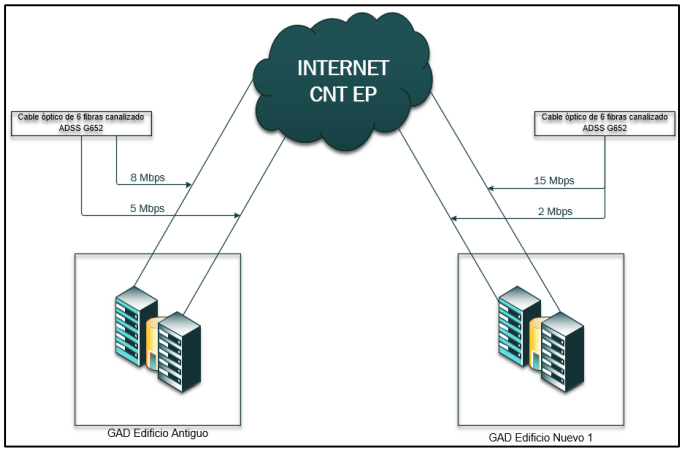

Figure 2: Physical Topology of the network contracted with the Carrier CNT EP
Source: Development of the project.

B. Design of the access network FTTB for the Municipal GAD Otavalo

1) Geographical situation of the city

The Canton Otavalo is located in the province of Imbabura, northern region of Ecuador. It has an area of 528 square kilometers. It is located 110 kilometers north of the city of Quito.

It then performs a description of each one of the municipal offices.

a) Municipal Building

Located in the center of the city, is where you run the coordination of the internal management and operation; suggests and proposing policies of administration, is also responsible for the human resources and material; manages the technical and financial cooperation of national and international activities, projects and programs of the Municipal Government.

b) Home The Jewel

It is a cultural center where they develop cultural activities, social, permanent museum that is exposed, and exhibition center and has attention to citizenship.

c) House of Tourism

Place in which exposes all the tourist part of the canton Otavalo, provides several services such as a travel agency municipal.

d) Municipal Commissioner

Schedules the reordering of the markets, fairs, and coordinates the work with several organizations of

merchants and artisans with the purpose of transmitting new ideas and proposals for improving the conditions of the sale and presentation of the productive activities of thousands of families.

e) The Hummingbird

The full name is Intercultural Center Kintiwasi Hummingbird house inaugurated in October 2011, is the special place where is observed throughout the city. Place the creativity and the spiritual awakening of young people in this place develops several activities such as:

- Training workshops.
- Trainings on different topics.
- Permanent art exhibitions.

f) House of the Youth

House of the youth is a cultural center, place where they develop workshops and courses of dance, ceramics, singing among others, aimed at young people who reside in the canton. In this site also work municipal units.

g) Municipal Winery

Site in which are stored all articles municipal and jointly the company operates municipal water and sewerage in the GAD Municipal.

C. Topology

The most appropriate topology according to the environment of the city and the location of each of the buildings is "topology tree", which is to connect the OLT with the UN's through passive optical distributors, where the descending channel GPON is a network point-to-multipoint where the equipment OLT handles all of the bandwidth that is distributed to users ONUs. In ascending channel is a point-to-point network where multiple ONUs transmitted to a single OLT. Through the use of splitters liabilities 1 x n (where n = 2, 4, 8, 16, 32, or 64) in different sites to reach customers. (Millan, 2016)

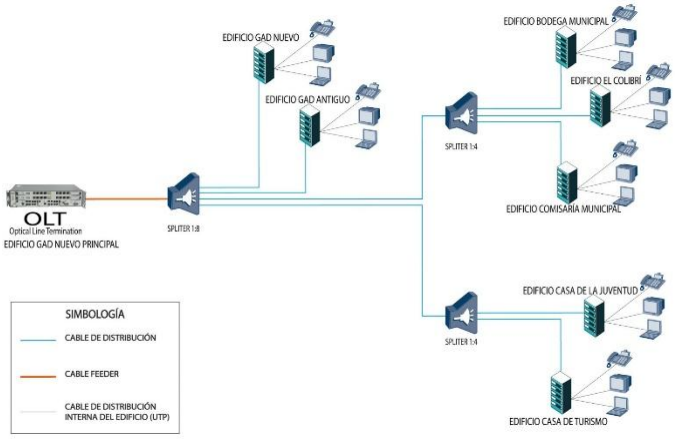

Figure 3: topology of a network PON Point - Multipoint
Source: Development of the project

D. Equipment and elements for the access network

1) OLT

The equipment OLT, suggested for the access network of Municipal GAD Otavalo is a product of the group HUAWEI which is a OLT small, since it complies with the technical requirements of this design and provide an excellent scalability to the network, because each card GPON has 8 ports offer maximum division of the splitter from 1:64 giving as a result of approximately 3072 connections.

2) ODN

It is formed by:

a) Spliters

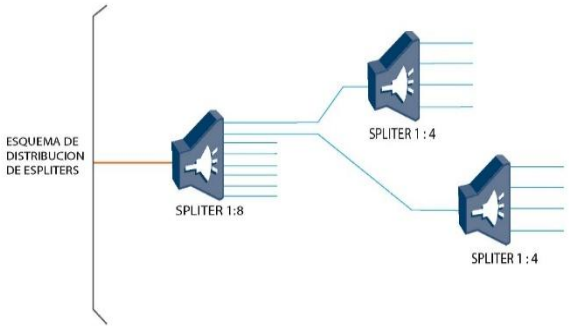

Figure 4: Splitters
Source: Development of the project

- It will have 1 card with 8 ports GPON.
- Each port of the card supports up to 64 ONT.
- It will have 1 primary splitter 1:8.
- Will be implemented 2 splitters that would service secondary buildings where the users are located.

b) ODF (Optical Distribution Frame)

It is a passive device, to which are attached the connectors of each fiber yarn, ODF located in the central node reaches the optical fiber for the building of the New Building Municipal GAD 2 (12 threads), the House of the Jewel (12 threads), the old building of the GAD Municipal (12 threads), and also the fiber that connects to the splitters secondary (12 threads) for this reason, this ODF must be able to hold at least 32 wires. Each one of the buildings to have in their rooms of telecommunications a ODF of at least 6 ports.

c) Connectors

Can be of different types, there are the metal for FC terminations or ST and plastics for terminations SC and LC as shown in Figure 4, it is important to bear in mind that the terminations both on one side and the other with the same type of polishing is this PC, UPC or APC. For this design uses 10 SC connectors/APC.

Figure 5: Types of fiber optic connectors
Source: Alvaro Llorente, 2013. Retrieved from: https://sites.google.com/site/stigestionydesarrollo/recuperacion/desarrollo-1/tema11/8---propiedades-y-tipos-de-conectores-de-fibra-optica

d) Optical Bridges

Are used for the interconnection between a port of ODF to which is conectorizado a fiber yarn of the link that comes from the outside with the transmitting equipment installed in the central or node. Need 15 patchcord.

Figure 6: Optical Bridges (Patch Cords).
Source: Operations Manual routing of fiber CNT EP

e) Pigtails

Are used to connect on the one hand the fiber that comes from the outside and connect by the other side to the coupler on the ODF. Need 15 pigtails.

f) Splice Sleeves

For the design of the network of access are required splice sleeves that is suitable for outdoor and q allow the leads suitable for each of the locations.

3) ONU

The ONU equipment, suggested for the access network of Municipal GAD Otavalo to each of its buildings, the equipment recommended is group HUAWEI SmartAX MA5626, since it complies with the technical requirements of this design and provide an excellent scalability to the network, is the ideal equipment for GPON technologies. You need 8 of these computers.

Figure 7: Huawei SmartAX MA5621
Source: Http://e.huawei.com/es/products/fixed-network/access/onu/onu-for-smartgrid

E. Determination of the length of the fiber optic cable

1) Power or feeder

For the calculation of the distance from the power cable or feeder will take into account the distance from the cabinet that houses the OLT toward the first post from where will begin the deployment of the cable, subsequently to this can be added the distance between post and post to reach each and every one of the primary optical dividers. In special case the

primary splitter is located in the central node because it is a BD splitter of 1:8 for mounting racks. Will require 10 meters.

2) Distribution Cable

To obtain the total distance of the cable distribution (distance between the primary and the splitter splitter secondary), you must remove the total distance of each zone, by summing all values. As shown in Table 2.

TABLE 2
DISTANCES FROM THE DISTRIBUTION CABLE SPLITTERS-ONU

CABLE DISTANCE DISTRIBUTION FROM THE SECONDARY splitter to the NLA (meters)	**Distance (m)**
GAD_OTA_NEW1-The_jewel	1843,27
GAD_OTA_NEW1-GAD_NEW_OTA2	50,46
GAD_OTA_NEW1-GAD_old_OTA	74,78
GAD_OTA_NEW1-Winery	176.70
GAD_OTA_NEW1-Commissioner	38.90
GAD_OTA_NEW1-Colibri	416.94
GAD_OTA_NEW1-TOURISM	429.64
GAD_OTA_NEW1-Youth	1228.21
TOTAL	**4258,90**

Source: Development of the project.

3) Calculation of reserve

For the calculation of the reserve of fiber optic cable, you must take into account the location and distance that will have the same, since it is necessary to dispense with some slack cable in certain cases such as: leads (bleeding of fiber optic), splicing of continuity, case in which ends the coil of optical fiber and is required to continue installing more cable, etc. measures that should be taken, considering the characteristics of the link and the sector to serve, (CNT, 2012).

TABLE 3
DISTANCES FROM THE DISTRIBUTION CABLE SPLITTERS-UN.

	Subtotal Distance (m)	**Reservation %**	**Saves Distance (m)**	**Total**
FEEDER	10.00	10%	1.00	**11.00**
Distribution OLT Splitter	1391.37	10%	391.37	**1782,74**
Un splitter distribution	4258,90	10%	258,90	**4517,8**

Source: Development of the project

IV. COST-BENEFIT ANALYSIS

It determines the feasibility of the project to be developed which will make it possible to evaluate the investment to be carried out taking into account not only the economic value, but also the benefit that this study represents for the GAD Otavalo. Municipal

V. COST ANALYSIS

A. Investment in the project

At this point is detailed the value of the equipment necessary for the implementation of this design described in Table 2. The analysis was based, in the equipment available in the national market, the popular brands and prices references the same.

TABLE 4
TOTAL COST OF ACCESS NETWORK EQUIPMENT FTTB

Total COSTS OF THE ACCESS NETWORK FTTB			
Description	Unit	Qty	TOTAL
Active EQUIPMENT OLT AND ONU	U	1	$13.060,28
Labor external equipment	U	1	$ 2.517,82
Equipment and items ODN	U	1	$14.750,80
TOTAL			**$30.328,90**

Source: Development of the project

B. Equipment depreciation

To bring a correct balance is necessary to consider the costs of depreciation of the equipment, for the present project is considered the useful life of five years since it is technological equipment with a value of depreciation of 20 per cent per annum. As shown in Table 5.

TABLE 5
DEPRECIATION COSTS OF ACTIVE EQUIPMENT

Depreciation		
Description	**Value of the equipment**	**Annual depreciation to 20%**
OLT BRAND HUAWEI SERIES MA5603T	$ 3.154,40	$ 630,88
ONT BRAND HUAWEI series HG8247	$ 6.356,72	$ 1.271,34
	TOTAL	**$ 1.902,22**

Source: Development of the project

C. Cost-benefit analysis

At the time to determine the feasibility of the project, will be verified in addition the benefits to be obtained with its development are greater than the investment required for its implementation. In such a way, lists the potential benefits that help people Otavaleña which is approximately 90.188 inhabitants[1] and that will be significantly improved by the future the complete execution of the access network FTTB, as shown in Table 6:

On the basis of the following approaches is determined that the project establishes very positive social benefits for the Canton Otavalo, so that its implementation is feasible for improving the conditions of access to the municipal workers in each one of the municipal offices which brings as a result of improving and facilitating the access of the population to the efficient public services and timely in a world increasingly digitized. In addition, the provision of technological tools of communication for the people and businesses in the sector, is a key point to increase tourism and productivity for the benefit of the socio-economic situation of the canton.

TABLE 6
BENEFITS WHEN YOU DEPLOY THE PROJECT

Cost-benefit analysis - DRAFT ACCESS NETWORK FTTB OTAVALO	
Cost	**Benefit**
Technology Migration	Flexible and dynamic Network, capable of transporting large capacities of traffic with the use of the optical technologies Greater traffic capacity that handle the municipal buildings. Fast and secure connectivity between municipal offices. Have a current access network and able to withstand applications of latest technology.
Acquisition of equipment	Maximize the current resources of transmission of the network. Acquisition of high-technology equipment that will allow the scalability of the network.
Resources and Applications	Data communications network of high fidelity. The inhabitants may improving municipal formalities payment of tax services. Integrate new services in each unit.
Maintenance of the network	Reliability and availability of the network.

Source: Development of the project

VI. CONCLUSIONS

One of the main advantages that present technologies FTTB, is that it uses the existing copper cabling internally from the buildings, which implies a reduction in the costs, because otherwise would implement a new wiring.

The laying of optical fiber air is the alternative, inside the city of Otavalo, due to that the implementations of underground pipelines represent a strong investment. The rent of pipelines in the present is not feasible due to the National Telecommunications Corporation that has such infrastructure is not the lease. On the contrary, the

[1] Census 2010, (Otavalo, 2015)

Electricity Company gives the possibility of leasing of poles for routing of optical fiber.

Was the design of this access network to interconnect the buildings of the Municipal GAD Otavalo, taking into consideration the geography of each of the buildings and the technical implications are fundamental for the development of the design in question.

It is necessary to consider the place, standard, architecture and topology selected and the characteristics in general the design, is summarized that the access network FTTB is ductile, scalable, viable and with a bandwidth admissible to give service of voice, data and video to each one of the municipal departments of Otavalo.

By the characteristics, technology GPON is superior to the wireless means and that handles speeds from 2.4/1.8 GB of lowering and raising the which allows you to benefit to the transmission services of information and applications on the internet. And in this way through theoretical calculations is said to have an availability of 99.98%.

Is raised in this study the connection of the 8 municipal offices of the GAD from Otavalo, for this was considered the suggested routes and evaluated according to the technical visit, same that will give stability to the network in the case of increase users.

 From the economic point of view the implementations of this type of access networks are not very expensive. If it is true, the costs of optical fiber are higher than the other technologies wireless or wired, are offset to some extent by be passive networks i.e. do not require electrical power. For this reason there is a design with the new technology and to take advantage of all the bandwidth that fiber optics can offer, so as to guarantee future, the use of the infrastructure investment, avoiding any neck of congestion of the service with the increase in demand.

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