Design Of A Main Ring And Redundante Of Optical Fibre Using Technology 10gpon To Optimise The Traffic Of The Network In The North Technical University

Jessica Torres[1], MSc. Carlos Vásquez[2]
Faculty of Engineering in Sciences Applied
North Technical University
Av. 17 of Julio 5-21 and Gral. José María Córdova
Ibarra - Ecuador
jxtorresr@utn.edu.ec, cavasquez@utn.edu.ec

Abstract - *In the actuality, the growth of the technology has gone growing of form enlarged, by what the future of the education is strongly conditioned by the technology, like this also the need of the people to be communicated and develop projects of investigation in all the areas of knowledge regarding the education and university learning. Because of these antecedents, the demwalks of widthof ban gives and speeds of transmission and n the campus of the north Technical University every time is mayor.*

The following project of degree bases in making a design for the implementation more advance of a ring of backbone of main optical fibre and redundante with networks PUT, the same that will help to optimise the traffic in the network of the north Technical University.

Key words*- Speed of transmission, optical fibre, networks PUT.*

.

I. INTRODUCTION

Desde a technological point of view a network of access is very important, this due to the fact that it allows to the final users have access to the different services through varied halfs of transmission, in the case of this project of degree the half is the optical fibre.

A network of backbone of optical fibre allows to the buildings of the campus of the north Technical University be connected to the central office, in where they find the servers and teams of communications, however, to measure that the technology and applications go growing and improving creates demands of greater capacities and bandwidths.

With the need to satisfy said demands, the proposal that shows to continuation, is the design of network of access

entirely of optical fibre with greater taxes of transfer and thinking in the needs of bandwidth by user that every year goes increasing, a network PUT is the option to resolve said lacking.

II. I DEVELOP

A. Optical Fibre

The demands of speeds of transmission have gone in increase and the half that covers these needs is in the actuality the optical fibre.

THE optical fibre is a half physicist of glass or of plastic that uses pulses of light issued by LED or Laser, with speeds of gigabits by second.

a. Advantages and disadvantages of the optical fibre

The optical fibre has advantages, as well as also disadvantages.

Between the advantages have the transmission of data to high speeds, better bandwidth, avoid electromagnetic interferences, better the quality of the formats of video and sound, in addition to a high reliability together with a long operative life with low values of mitigation.

Now, they show some disadvantages, like the cost of installation that is more elevated in comparison to the wire of copper or coaxial, in addition to the repair that needs of skilled teams.

b. Types of Optical Fibre

The optical fibre classifies by the type of propagation of the light. A way of propagation is the number of paths that follows the light inside the fibre and are: monomodo and multimodo.

Optical fibre Monomodo

This type of fibre propagates only a way of light because of his diameter of core that is infinitely small, as it observes in the figure.

Fig. 1. Propagation of fibre monomodo

Fibre Multimodo

This type of fibre propagates more than a way of light, used for applications to short distances. They are classified by his index of refraction in the core, of staggered index and of gradual index.

In the fibres multimodo of staggered index, the optical rays travel simultaneously and reflect in different angles on the wall of the core, because of this visit different distances.

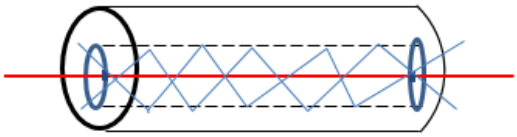


Fig. 2. Propagation fibre multimodo of staggered index

A fibre multimodo of gradual index the core is constituted of different layers of materials with different ídicices of refraction. What does that the light refracte as it observes to continuation.

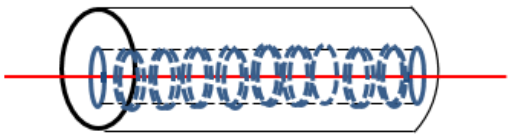


Fig. 3. Propagation fibre multimodo of staggered index

B. Networks of Access via optical fibre

This type of networks of access are of high technology, with taxes of transmission that surpasses the ones of

copper. They classify in networks HFC and PUT.

a. Networks HFC

This network is of hybrid type, a combination of coaxial and of optical fibre, allows the deployment of services like data, telephony and internet.

b. Networks PUT

This type of networks allows to delete the existent active components between the server and the customer, to plant in his place passive components, conformed by three basic elements.

- OLT (Optical Line Terminal)
- Divisor Optical (Splitter)
- UN (Optical Network Unit)

The OLT is the one who transports the data from the head office until the divisor optical.

The Divisor Optical, splitter, receives wires of optical fibre of entrance and gone out and what does is to divide the signal.

The UN receives the information that arrives from the splitter.

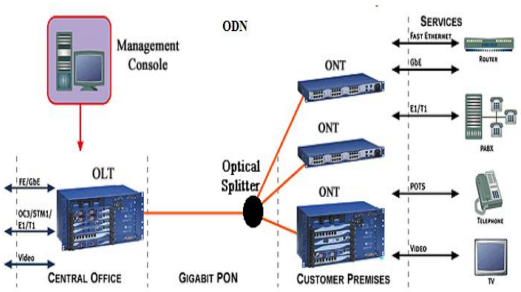


Fig. 4. Diagram of Network PUT

C. Type of Networks PUT

The networks PUT calcifican of agreement to the standard and low that protocol was developed, to continuation, summary the types of networks PUT.

TABLE 1.
TYPE OF NETWORKS PUT

Tipo	Estandar	Caracteristicas Adicionales
APON	ITU-T G.893	a) Basa su transmision en ATM b) Tasa maxima de 155 Mbps, repartida entre ONUs c)Llega hasta velocidades de 622 Mbps
BPON	ITU-T G.893	a) Se basa en APON b) Da soportes a otros estandares de banda ancha
EPON	IEEE 802.3ah	a)Se basa en trafico Ethernet b)Fue realizada especificamente para aprovechar el EFM c)Trabaja con velocidades hasta de 1.25 Gbps d)Se reducen los costos ya que no utiliza elementos ATM y SDH
GPON	ITU-T G.894	a) Desarrollado sobre ATM b)Se basa en la arquitectura BPON c) Ofrece cobertura hasta 20 km d) Da soporte global multiservicio como voz, entre otros e) Soporta velocidades hasta 2.5 Gbps
GEPON	IEEE 802.3ah	a) Desarrollado sobre Ethernet b) Tiene las mismas caracteristicas que la GPON
HGPON [11]	ITU-T G.894	a) Desarrollado sobre ATM b) Caracteristicas similares a la GPON c) Tiene mayor capacidad de ancho de banda

D. Networks 10GPON

10 Gigabit Capable Passive Optical Network, standard for transmissions of bandwidth with capacity of 10Gbps on networks PUT and with any type of architecture FTTx. The main aim of the networks 10GPON is coexistir with networks GPON, also offers the development of services of new generation eat: videoconferences, IPTV, HDTV, triple services play, among others.

The standard G.987 of the UIT-T includes the following recommendations

- G-987: Definitions, Shortenings and Acronyms (XG-PUT)
- G-987.1: General Requests (XG-PUT)
- G-987.2: Specifications of the layer PMD (Physical Half Dependent) (XG-PUT)
- G-987.3: Specifications of the layer TC (Transmission Convergence) (XG-PUT)

The standard 10G-PUT applies for any type of network of access or architecture type FTTx of passive

networks, in the figure 36 can observe the architectures of networks PUT in that it considers the point until where the optical fibre extends .

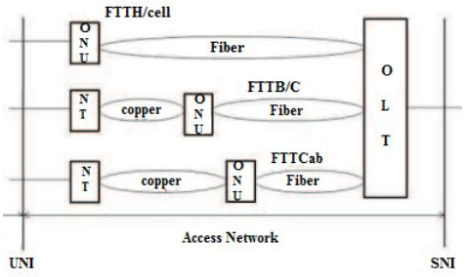


Fig. 5. Architecture Network XGPON

E. Design of the Network of Optical Fibre

For the design of this project have considers important factors like the current situation of the capacity of each link troncal that arrives to each one of the buildings, in addition to the number of current users and a projection of 5 years to the future to the equal that the projection of applications that can bear the network of access of optical fibre that designs .

a. Establishment of the Type of Technology to Use

For the design goes to use the architecture PUT the same that deletes active elements replacing them by passive.

Because of his multiple advantages and in base to the general request for the design chose the technology 10GPON with the standard with which works, first draft of ITU-T G.987; although the technology exceeds the capacity sued that it is of 133Mbps by links, by a lot of and considering that GPON is more suitable, decided developed the project with10GPON due to the fact that it was a main request of the design.

i. Advantages of the Technology 10GPON

The standard 10GPON describes broadband transmissions with speeds of 10Gbps on networks PUT and on any type of infrastructure FTTx, with maximum taxes of transmission for XG-PUT1 of 10Gbps downward and 2,5 Gbps ascending.

b. Determination and description of teams to use

The network will be designed for eleven buildings with connection of links troncales of fibre to each one.

In the table to continuation, show the teams to use in the design.

TABLE 2.
TEAMS To USES IN THE DESIGN OF THE NETWORK OF

FO Team to Use	Quantity	Distance
OLT	1	-
UN	11	-
Splitter (2x8)		
Boxes of Distribution	2	-
Rosettes	11	-
Atenuador	4	-
Wire Drop	1	2,5Km

For the design of this project and to know the requests of the OLT used the measurements of the traffic and the capacities of each link of the network of backbone optical fibre. It determines of the same it forms the maximum capacity according to the recommendation G.987.1 of the standard 10GPON that mentions that each card of the OLT can reach 10Gbps of descent and 2,5 Gbps of rise, therefore, as it determined previously will plant two Splitter arriving with a card of the OLT to each one adding two ports of backup for a total of 4 ports.

The Splitters are the passive elements in an optical network, is the attendant of the distribution of the connection of the

topology point multipunto formed by the OLT and the users, depending of the number of users and the traffic that goes through each link troncal and knowing the distances to which find the buildings, for the design of this project have an alone level of splitters. The number of splitters to use will be two, of type 2:8, in where each exit will arrive to the terminal box of optical fibre in the buildings situated north and south of the campus of the university.

c. Redundancy of the Network of Optical Fibre

For the design of this project chose the Redundancy of systems PUT Type B, because of his architecture that reduces the cost of acquisition of ONUs extra and installation. In this configuration, the loss of connection and even of plots is unavoidable in the period of conmutación, of agreement to the norm the period of losses of plots is inferior to 120ms. The type of network of the present design considers a network of access with need of bidirectional traffic with a time of recovery in the order of the minutes.

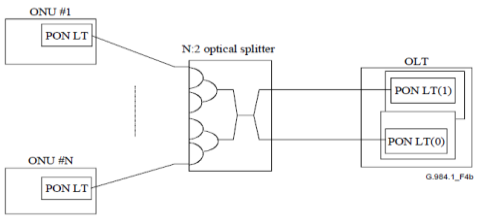


Fig. 6. Redundancy in OLT Type B

d. Topology of the Network

For this design chose the topology type tree-branch with which looks for flexibility. Also(( )) it chose this topology by the geography of the stage.

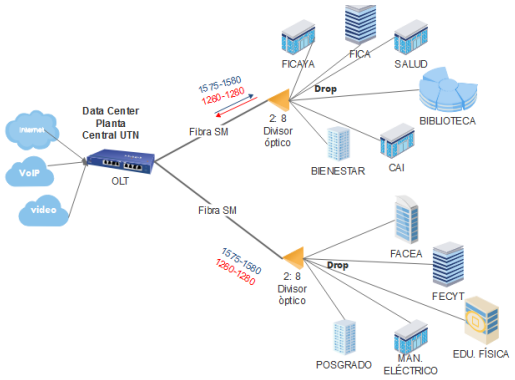


Fig. 7. General topology of the design

e. Diagram of the Design of the Network

To have a better assessment of the design of the network the diagram represents on a plane of the campus of the university, in which it observes the level of splitter and the wiring through installation by ductería.

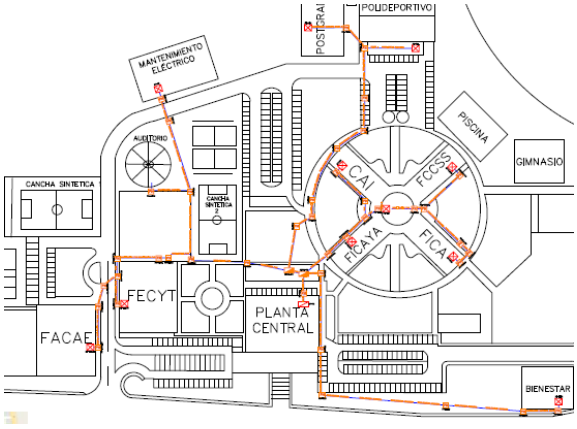


Fig. 8. Network in the interior of the university campus

F. Referential Budget of Teams

When it refers to convenient prices, speaks of prices in the market of all type of teams, wire and accessories for the design of this network. The total cost approximated of the network is the sum of costs, that is to say the purchase of active equipment, passive, hand-held cost of work, that uses for the installation of the teams, to continuation, show in the

tables the referential prices of the elements that go to use in the design.

TABLE 3.
ACTIVE EQUIPMENT

ITEM	Descripción	Unidad	Cantidad	Precio Unitario	Precio Total
1	Huawei MA5608T - Mini OLT	Unidad	1	29.342,41	29.342,41
2	ONT Huawei	Unidad	11	200	2200
				SUBTOTAL	31.542,41
				IVA (14%)	4415,94
				TOTAL	**35.958,35**

TABLE 4.
PASSIVE EQUIPMENT

ITEM	Descripción	Unidad	Cantidad	Precio Unitario	Precio Total
1	ODF 12 puertos -Incluye: adaptadores, pigtails, bandeja de empalme y tubillos para protección de empalme	Unidad	1	135,00	135,00
2	Splitter PLC 2x8 conectorizado JFOPT	Unidad	2	60,00	120,00
3	Caja de Distribución Óptica exteriores TOPSTONE - Incluye bandejas porta splitter y 12 adaptadores SC/APC Splitter 2x8	Unidad	2	135,00	270,00
4	Caja para alojar fusiones Roseta FO, 4 puertos LC/APC. Inlcuye 4 adaptadores LC/APC	Unidad	11	12,00	132,00
5	Pigtail SC/APC, SM G.657A1. 1.5m de longitud	Unidad	11	3,5	38,5
6	Patchcord FO LC/UPC-SC/APC, SM G.652D, duplex, 3m JFOPT	Unidad	15	12,00	180,00
7	Plug Attenuator JFOPT	Unidad	4	10,00	40,00
8	Fibra Óptica JFOPT - Cable DROP - 2 hilos	Metro	2200	0,50	1100,00
				Total	**2235,5**

TABLE 5.
COST HAND OF WORK

ITEM	Descripción	Unidad	Cantidad	Precio Unitario	Precio Total
1	Tendido cable fibra óptica	m	2200,00	0,60	1320,00
2	Armado de ODF, caja de interconexión o caja terminal	unidad	14	15	210
3	Fusión hilo de FO	unidad	24	15	360
				Total	1890,00

To continuation, in the table 6, shows an approximate cost of what the design will be able to cost.

TABLE 6.
APPROXIMATE TOTAL BUDGET

ITEM	Descripción	Cantidad
1	Equipamiento Activo	35.958,35
2	Equipamiento pasivo e instalación de FO y mano de obra	4657,47
	TOTAL	**40.615,82**

G. Budget of Power of the Network

In the calculation of budget of power include , the losses of insertion, 3dB of margin of error and by atenuador. According to the standard 10G-PUT works in two ranks of ascending and downward wavelengths, in the tables to continuation shows the analysis for the two types of transmissions, besides observes the diagram of the elements of the network of each link.

It considered add atenuadores to each port of the OLT, 4 in this case; due to the fact that by the short distances and without considering the value of margin of error, the budget of power will remain underneath of the lower value of mitigation of the ODN to the established in the standard 10G-PUT, however, in the calculation of budget of power by link would suffice to add him the loss of the atenuador, in the case of not considering the 3dB of security.

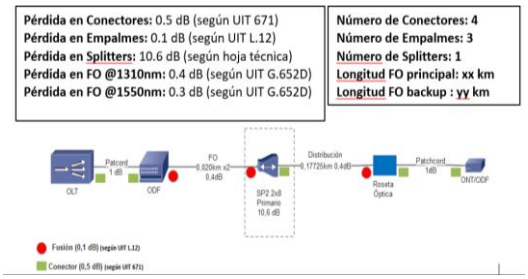
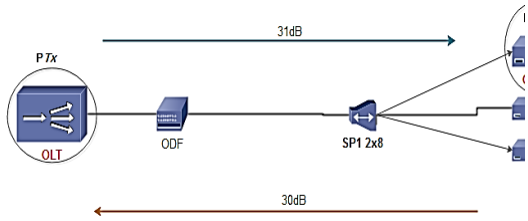


Fig. 9. Calculation of budget of power by link

Obtaining an average of 16,6 dB of loss, taking in account these values can conclude that, the values in all the cases find inside the rank of maximum

mitigation and supported minimum by the ODN.

To obtain the budget of power from the segment of network of the OLT to the UN takes in account the values of the power of maximum transmission, the sensitivity of maximum reception of the transmission of these active teams. In the figure 10 observes the budget of minimum power and maximum of the link.



It appears 10. Budget of power active teams

Considerando the lower value that is of 30 dB like reference, can determine that the budget of power required by the previously defined links is lower that the one who offer the active teams. In conclusion, it establishes that the signal sent from the OLT arrives to the receptor and avoids that this sature deleting the possibility that it suffer damages because of the reception of greater signals to the maximum power of reception of the device.

III. CONCLUSIONS

The recommendations of the standard of technology 10GPON and his sections in specify the data of losses of the element that take part in an optical network, also designed the main ring and redundante of logical form based in the configuration of passive teams redundantes in this case the splitter, in addition to the analysis of the budgets of power that guarantees that the optical signal will arrive to each team ONT in each building, of this form the design of the present project guarantees the correct operation to be implemented as it require the institution.

With you report them by week of the number of users in the hours hammer in each one of the access point of each building of the university campus, made the calculation of the Factors K, parameters that served to make the projection of the capacity of the network of access of optical fibre

The graphic statistical and data of the capacity by links that provided the tool of monitory NTOP facilitated to determine the minimum capacity that it is of 333Mbps for the link troncal of fibre of Postgraduates, thanks to these data made a suitable dimensioning of the network and generated the necessary requests for the teams to use in the design of this project.

It chose the technology 10G-PUT for the development of the design of the ring of main optical fibre and redundante of the university campus in base to the specification in the subject of the design of this project, however, concluded that for taxes of transmission in the order of the Mbps, data obtained of the monitory of the network troncal of optical fibre and of the needs that has the network of the university, the technology that covers the demand and is more feasible to use is the technology GPON that to the equal that 10GPON replaces the active teams with passive and does simpler the administration of the network, with tax of minimum transmission of 2,4Gbps sufficient capacity to offer the services with a high availability and efficiency, by at least during 5 years, of agreement to the calculation of projection of the capacity.

When making the calculation of budgets of power by link, the value of

margin of security of 3dB can not being required, because of the wide remaining value of dBs, however, considered in the calculation not to remain underneath of the lower limit of mitigation according to the standard of 10GPON regarding the ODN, like alternative also presupuestó an atenuador with a loss of 1dB minimum quantity to surpass the minimum value required of budget in the links, anyway, taking in account the 3dBs or planting an atenuador in each port(4) of the OLT, the budget by link surpasses the 14dB of minimum loss in the ODN of the standard ITU-T G.987.2 Gigabit Passive Optical Networks, by what can say that it adjusts to the norm of the design and ensures that the signal from the OLT arrive to the receptor and vice versa.

With the obtaining of the minimum requests of the teams and the help of the data of the maximum capacity by link, attained situate in the planes the distribution of the network of access of optical fibre and following the recommendation of the ITU-T L3 considered use the installations of ductería and pozos existent with the purpose to reduce the costs in installation and hand of work.

IV. RECOMMENDATIONS

The active teams have to be compatible. It is recommended that these teams are purchased from a same manufacturer to avoid losses in the transmission of data.

The installations of the ductería and pozos in where the backbone of optical fibre that encentra placed, is suitable, however, of agreement to report them given of courts sucintados in the installation of the elevators in each building, will be necessary to plant strips that indicate the place and those that metres under earth finds the wire of optical fibre, with this will be possible to avoid said problems because of bad practices to the hour of the installation of matter of optical network.

In the campus of the university as it indicates in the design of this project exist ducterías, the same that do not find in the suitable conditions, as for example pozos full of water and covered of maleza, what causes that the wire of optical fibre go wearing out as it happens the time; it recommends they carry out works of maintenance or processes of hermetical closings in the pozos PM-PC01 and PM-PC02 in where they would go situated the boxes of distribution of the design of the present project.

Make an analysis and lifting of the topology of the network wired up and wireless in each one of the buildings of campus of the university, would do easier the work of the analysts of networks that work in the department of computing, those who occupy of the administration and management of all the network of the north Technical University. With the report of said analysis could make a suitable study for the placing of ONTs in the offices and cubicles of authorities and administrative personnel that labora in each one of the buildings and arrive until the places of work with optical fibre.

For the analysis of budget of power of each link suggested plant atenuadores in each port of the OLT, because of the considerations posed in the design of the present project; it recommends use an atenuador of type plug of the same manufacturer that the patchcords JFOPT that go of the OLT to the ODF, for descartar problems in the attachment, the referential cost is considered in the cotización of the rest of materials.

In the actuality does not exist variety in the demand of teams of communications that bear the specifications of the standard 10GPON since it is a more or less new technology that finds developing and only has approved the requests of physical layer for the version XG-PUT1 and no for the XG-PUT2, by what would have to be important be to the so much of the changes and updates that go making, in space in the levels of mitigation and minimum and maximum capacities recommended for the passive optical network and active and passive equipment.

V. REFERENCES

[1] Calvo, M. L. (2007). Chromatic dispersion. 5.

[2] Chomycz, B. (2011). Installations of Optical Fibre. Foundations, technical and applications. Hamburg

[3] Cofitel. (2014). You aim of Optical Fibre. OPTRAL.

[4] Govind, To. (2002). Fiber Optic Communication Systems. Rochester , New York.

[5] Engineering, G. d. (2001). Methods of Projection of Population

[6] Street, And., & Peñafiel , C. (2012). Design of a ring of optical fibre to connect the head offices of yalancay, sibambe and the repetidora of Ayurco in the sector south of the province of Chimborazo. Riobamba, Ecuador.

[7] Paspuel, D. (2014). Optimisation of the Bandwidth of Access to Internet and Control of Traffic of the north Technical University Applying Quality of Service.

[8] Velasco, M. (2009). Design Of A WISP In The Campus Of The North Technical University To Cater Services Of Wireless Internet Using A Diagram Wireless Mesh With Technology [9] CIEMTELCOM, (2014). Fibre Piped. Obtained of: https://goo.gl/ywvsdp

[10] Technologies of the Information and the Communication. (2008) Types of optical fibre.

[11] Laboratory of Optical Communications. (2009). Systems of Optical Communications.

[12] Simoni, C. (s.f). Optical fibres. Obtained of: http://www.ieee.org.ar/downloads/2008-simoni-fibras.pdfwifi.

VI. BIBLIOGRAPHIES

Jessica Torres R. It was born in Ibarra-Ecuador on 01 November 1991. His primary study made in the school María Angélica Gotheft and secondary in National School Ibarra. Member IEEE from 2013- managerial IEEE-UTN in 2015. Currentmind egresado of the career of Engineering in Electronics and Networks of Communication in the north Technical University.

Carlos A. Vasquez It was born in I Remove - Ecuador on 19 September 1981 . Engineer in Electronics and Telecommunications, National

Polytechnical School in 2008. At present it is educational of the Career of Engineering in Electronics and Networks of Communication in the north Technical University, Ibarra-Ecuador, and is graduate of the Mastery in Networks of Communication, Pontificia Catholic University of the Ecuador, Remove- Ecuador