International Journal of Electrical, Electronic and Communication Sciences
ISSN: 2517-9438
Vol:9, No:10, 2015

Transmission Performance Analysis for Live Broadcasting over IPTV Service in Telemedicine Applications

Jenny K. Ubaque, Edward P. Guillen, Juan S. Solórzano, Leonardo J. Ramírez

***Abstract*—**The health care must be a right for people around the world, but in order to guarantee the access to all, it is necessary to overcome geographical barriers. Telemedicine take advantage of Information Communication Technologies to deploy health care services around the world. To achieve those goals, it is necessary to use existing last mile solution to create access for home users, which is why is necessary to establish the channel characteristics for those kinds of services. This paper presents an analysis of network performance of last mile solution for the use of IPTV broadcasting with the application of streaming for telemedicine apps.

***Keywords*—**Telemedicine, IPTV, GPON, ADSL2+, COAXIAL, Jumbogram.

I. Introduction

TELEMEDICINE services is the use of Information Communication Technologies –ICT in order to increase the people access to care services or to information related to the health system. The World Health Organization defines Telemedicine as;

> "The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities" [1].

Nevertheless in recent years the distance is not the only critical factor, but the reduction on attention time and opportunity to access the health system. Some of the telemedicine services are classified as follows: Teleconsultation is supported with the tool EHR (Electronic Health Register), Telediagnosis with specialty services Teleendoscopy, teledermatology, TeleOphtamology, TeleOtolaryngology; Telecare, TeleHealth education, Teletherapy of specialty TelePsychiatry, Telephysiotherapy, Teleprescription, Telepharmacy, Telemetry specializing in Teleradiology, Telephathology, Telecardiology, Telehealth management [2].

IP networks are widely used for multimedia applications in telemedicine services overhanging teleconsultation using video-conferencing in real time for consultations with specialists [3], and IP streaming is useful in real-time transmission of medical images ECG to Telecardiology services [4]. Among those technologies, the streaming apps could be deployed in existing IP technologies in order to be applied for a wide number of users. To increase the capacities of network features it´s important to analyze the throughput over an existing available service such as IPTV in traditional last mile solutions such as xDSL, Coaxial and GPON.

The analysis tries to establish the maximum transfer unit for last mile solutions for IPTV protocols to calculate the possible throughput increase if IPv6 Jumbograms are employed as a layer 3 solutions for future IPTV streaming applications in telemedicine for home users.

In the Section II, some related work is presented; Section III shows the methodology to analyze scenarios and Section IV is intended to discuss some results.

II. Related Work

IPTV is a set of modern technologies of Next-Generation Networks – NGN that combines the television over IP and allows the provision of high quality services as triple play [5], the convergence of these services are defined by ITU as

> "multimedia services delivered over IP based networks managed to provide the required level of quality of service and experience, security, interactivity and reliability" [6].

According to services and parameters, a generic architecture is similar as shown in Fig. 1, the schemes is based on three basic blocks:

- The first block is the acquisition of content as the coded signal by satellite or terrestrial broadcast transmission. The signal is fragmented and encapsulated in MPEG-2 or MPEG-4 format. [7]
- The second block (Meter Network) distributes the content of the previous block by channels as mechanism of transport.
- The last one (Last Kilometer) receives packets from meter network and finally transmitted to end-user devices [7].

IPTV architecture and services are supported on wide range technologies, some of the main are: GPON, ADSL2+ and COAXIAL. Gigabit Passive Optical Network –GPON uses a fiber optic network with transmission rates of gigabits [9]. Whereas Asymmetric digital subscriber line 2 Plus –ADSL2+ implements two-wire copper network and has double of

Jenny K. Ubaque, Edward P. Guillen, Juan S. Solórzano and Leonardo J. Ramírez are with the Telecommunications Engineering Department, Military University Nueva Granada Bogotá, Colombia (e-mail: securityinvgroup@ unimilitar.edu.co, edward.guillen@unimilitar.edu.co, gissic@ unimilitar.edu.co, tigum@unimilitar.edu.co).

capacity of ADSL [10]. COAXIAL is a media that transmit telephone, internet also TV [11] and uses a copper conductor wire, the copper is extending throughout the axial axis shaft insulated rings [12].

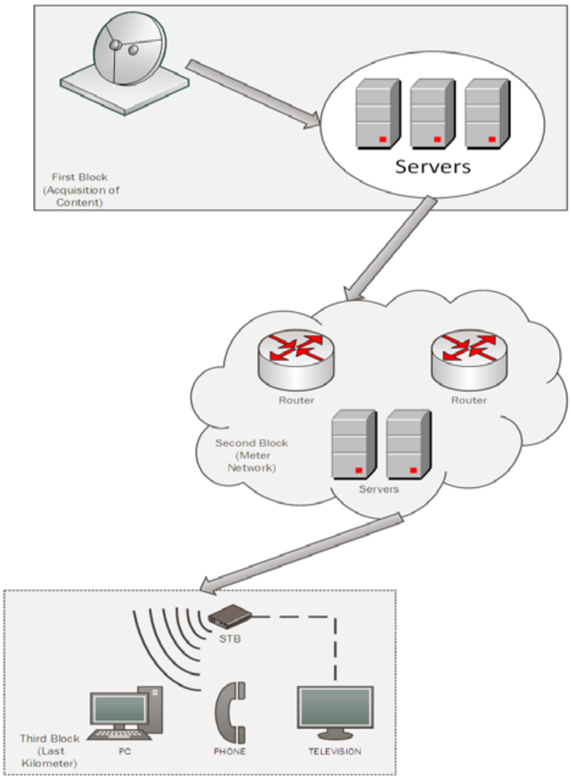

Fig. 1 Generic Architecture [8]

TABLE I
MEDIA FEATURES

	GPON	ADSL2+	COAXIAL RG-59	COAXIAL RG-59
Upstream (Gbps)	2.5	1.2	120	120
Downstream (Gbps)	1.2	2.4	160	160
Encapsulation Method	GEM	L2TP	DOCSIS 2.0-3.0	DOCSIS 3.0
BER	10^{-12}	10^{-9}	10^{-8}	10^{-8}
Distance	20	< 1500	10	10

The units are Gbps = gigabit per second, Distance (Km) = Kilometer.
GPON is from ONU to OLT (Km), ADSL2+ and COAXIAL is from Central to Subscriber.

The main features of these technologies are shown in Table I as: transfer rate of upstream and downstream, encapsulation methods, bit error rate -BER and distance [13]-[19]. Encapsulation methods are presented by Table I. Following describes those media:

GPON Encapsulation Method –GEM is an encapsulation method and data transport mechanism over GPON inside the tunnel. Technology GEM is considered as an efficient transport mechanism in the GPON network, due to it allows a higher bandwidth and flexibility in the GPON network. GEM adds 5 bits to the header with a 4095 bytes maximum payload, also it is an efficient mechanism of transport in the GPON network that allows a higher bandwidth and flexibility in the GPON network [20].

Layer Two Tunneling Protocol –L2TP is a multi-protocol encapsulation that transports packets through of second layer on a point-to-point connection. The point-to-point protocol – PPP use two types of messages: control messages and data messages. Control messages are used to establish, maintain and clean the tunnels. Data messages are used to encapsulate PPP frames that travel inside the tunnels. [21]

Data Over Cable Service Interface Specification –DOCSIS 3.0 belongs to the family of DOCSIS and introduces a new layer (MAC). MAC defines a mechanism to increase the maximum speed of data loading and unloading between the CMTS and the CM. The mechanism uses the feature of Channel Bonding that allows the ISP to configure the QoS parameters for a multicast traffic. DOCSIS 3.0 includes support for IPv6, where the supply and management of a CM is introduced with an IPv6 address; it also gives the possibility to manage transport and IPv6 traffic. [22]

IPTV services operate on Internet Protocol version 4 –IPv4 but have some issues as: limited band, users' limitation, and no QoS guarantee. It makes that IPTV does not use its maximum capacity [23]. Taking advantage of Internet Protocol version 6 -IPv6, a study was carried applying Jumbogram to see the advantages and progress in a possible increase of the MTU [24].

Larger packages, known as Jumbograms, allow performing various analyses to find various MTU shortcomings, they increase their header and find values of service delay among others [25]. Jumbogram is an IPV6 package that contains a greater payload to 65,535 Bytes, a payload format has a length of 32 bits to allow a simultaneous transmission of IPV6 packets with payload between 65,536 Bytes and 4.299.967.295 Bytes.

A Jumbogram has a payload to zero in the header and a next header value of zero, this process is known as Hop-by-Hop. Fig. 2 presents a Jumbogram header, showing each of the fields that comprise it [26], [27].

III. METHODOLOGY

This section examines the performance of connection-oriented networks to analyze the following parameters:

A. Parameters to Analyze Performance Connection

1) Error detection and correction: the connection-oriented between different devices are characterized by requests for shipment confirmation and data delivery through the medium. This process is verified by the parity bit in the frames, but actually, it has been replaced by the Automatic Repeat request –ARQ [28]. ARQ aim is to obtain the comprehensive forwarding frames that are possibly incorrect or damaged in real-time, without needing a minimal quantity of bits to assure the required level for error detection and correction.

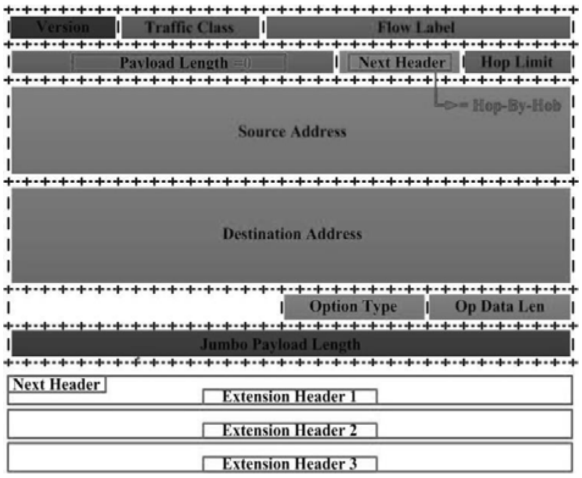

Fig. 2 Jumbogram header [26]

The confirmation frames of data flow can be received by two types of frames: first is acknowledgment received -ACK and second negative acknowledgment –NAK. Time intervals allow to this type of confirmations to avoid the deadlock during the frames shipment, in case the transmitter does not receive a response (ACK or NAK) the frame will be repeated.

Performance analysis of GPON, ADSL2 and COAXIAL media to error detection and correction can use two processes, the first is the only transmission frame waiting for an ACK / NAK or end of timeout, the second is based on a continuous transmission of frames that is interrupted only a NAK or when the timeout expired again initiating the transmission of frames, Fig. 3 shown an instance. The transmission of frames on IPTV is continuous due to its performed in real time and require a maximum efficiency in the media to offer QoS.

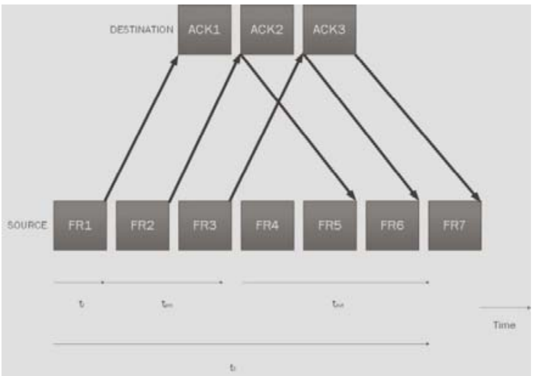

Fig. 3 Continuous transmission of frames [29]

2) Media Performance Variables: the variable BER in continuous transmission of frames is obtained by the probability value that a frame does not contain any errors (1- Pb), raised to frame size with a header of size ℓ' in values of bits, also it contains the variable size data l in bit values for a total in bits $(\ell + \ell')$ [29].

$$P = 1 - (1 - P_b)^{\ell+\ell'} \quad (1)$$

The time to set the channel frame in t_I is proportional to the size of frame and channel's capacity calculated in bps [29].

$$t_I = \frac{(\ell+\ell')}{C} \quad (2)$$

After the time of frame placement on channel (t_I) is obtain, the confirmation delay time of frame arrival (t_{out}) will be obtained too, It corresponds to the sum of the propagation time (t_{pro}) in both senses and the duration for assembling a confirmation frame, finally the processing time of the destination is added.

Total time t_T corresponds to duration of media connection or the transmission of the data flow, total time is obtained as the result of the times described above sum. However processing times are despised when channels are faster, these times only can be used when the device is slower than the channel. The total time is calculated using equation 3, if processing times are despised [29].

$$t_T = 2t_I + 2t_{pro} \quad (3)$$

In this case, it is assumed that errors will not occur during the transmission of frames to obtain better performance on links. Equation (4) is expressed as:

$$t_T = t_I + t_{out} \quad (4)$$

If an error occurs during the frames shipment, the total time would be $2t_T$ multiplied by the number of times that sent frames. [29].

To analyze the performance of the studied case to change the MTU works with a time relationship with constant value ≥ 1 reducing to the following relationship [29]:

$$a = \frac{t_T}{t_I} \quad (5)$$

For a detailed analysis is recommended to create a comparative graph between multiple media and to analyze the best performance by implementing Jumbograms, based on the relationship called "speed normalized data" obtained by dividing the speed and capacity of the channel (D/C) with a time constant ≤ 1, represented by (6):

$$D/C = \frac{\ell}{\ell+\ell'}\left[\frac{(1-P)}{1+P(a-1)}\right] \quad (6)$$

IV. Analysis of Result

A. Individual Analysis of Media Performance

Five test scenarios were implemented to analyze the performance of GPON, ADSL2+ and COAXIAL links for applications of IPTV, implementing IPV6 Jumbograms that are explained in Table II.

The mathematical analysis carried out on media GPON, ADSL2+ and COAXIAL implementing IPV6 Jumbograms allowed altering the values of MTU and improving performance by up to double the flow of information. The results show that the media COAXIAL has a greater performance with limited bandwidth, due to the encapsulation method DOCSIS 3.0 that is characterized by using a Channel Bonding system, the results are evident in Fig. 4.

TABLE II
FEATURES OF LAST MILE SOLUTIONS

Links	Stage	Capacity (Gbps)	Propagation Speed (m/s)	Headboard (Bits)	Distance (Km)	BER
GPON	1	2.5	299792458	40	5	10^{-11} 10^{-10} 10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5}
ADSL2+	2	1.4	194865098	32	5	10^{-11} 10^{-10} 10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5}
Coaxial	3	120	197863022	56	5	10^{-11} 10^{-10} 10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5}
	4	120	254823589	56	5	10^{-11} 10^{-10} 10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5}
	5	120	254823589	1976	5	10^{-11} 10^{-10} 10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5}

The units are Gbps = gigabit per second, m/s = meter per second, Bits, Km = Kilometer

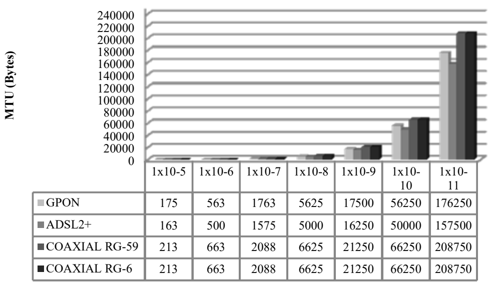

Fig. 4 Maximum MTU values in Bytes with a wide range of BERs

The comparison between the stage 3 (Coaxial RG-59) and stage 4 (Coaxial RG-6), is evident in Fig. 5, this comparison determined the difference between the two types of media that carry the IPVT service, the difference corresponds to the speed of propagation, the performance of these media do not present differences although modify the MTU settings.

Fig. 5 presents the comparative analysis between the scenario four and five, determining that performance of the coaxial is higher when you have greater header in the transmission protocol, due to the frame of DOCSIS 3.0 does not use the EHDR field in the scenario four and the frame of DOCSIS 3.0 uses the whole field EHDR in the scenario five.

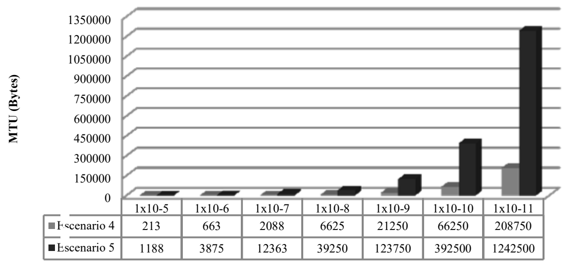

Fig. 5 DOCSIS 3.0 with EHDR Vs DOCSIS 3.0 without EHDR

V. CONCLUSION

Performance analysis implements over different data transmission systems as coaxial, ADSL+2 and GPON allows to conclude that media factors as: capability, propagation speed and distance does not directly affect the performance media, due that the parameters only used in relationship of time to normalize data in intervals range from 0 to 1.

The comparative analysis between platforms indicated that although in general GPON has best capability, it does not have the major transmission performance; coaxial has a lower bandwidth with high efficiency of transmission. This finding allows concluding that the more important aspect to improve the transmission performance is the encapsulation protocol that can supply the medium. For example in this study, the coaxial cable that uses DOCSIS 3.0 with a Channel Bonding system, performs full logical processing and it increases the throughput, also it provides optimum performance in the services that used this data transmission systems, due to the stability of this protocol that it allows a higher setting of QoS parameters. Additionally, the mathematic analysis determined that in the different data transmission systems, the BER parameter and the head of the transmission protocols is major performance properties, among more higher transmission header and lower BER, the higher the throughput of the transport medium.

The increase in value in the MTU's on the data transmission systems by applying IPv6 Jumbograms, It was verified that the three technologies has a rate of 0.9 % to 0.99% performance, but at present the data flow is limited to 1500 bytes.

It is recommended for future works, to improve the coaxial performance through of MTU in its BER characteristic. It uses there optional headers, which would have a capacity of up to 39250 bytes due to the users only use of 3.8% of maximum capability that this system can offer for IPTV services.

The implementation of MTU's with larger frame sizes makes easy the modification of frames, to significantly reduce the real-time transmission issues such as jitter, latency, and other factors that affect the performance of services and it would improve the streaming service in telemedicine apps.

ACKNOWLEDGMENT

This work was supported in part by Military University Nueva Granada under Grant ING-1772. The authors would like to thank the GISSIC group for providing tools for development of testing scenarios.

REFERENCES

[1] World Health Organization, Telemedicine: opportunities and developments in Member States: report on the second global survey on eHealth 2009, ISBN 978 92 4 156414 4
[2] Guillen, E., Estupiñan, P., Lemus, C., Ramirez, L. "Analysis of security requirements in telemedicine networks". vol.21, n.2 , pp. 57-89, 2011
[3] Rong-Yu Qiao; Bengston, K.; Krumm-Heller, A.; Hogan, M., "A Critical Care Telemedicine System on Broadband IP Networks," Communications, 2005 Asia-Pacific Conference on, pp.852,856 Oct. 2005
[4] Sangal, A.K.; Satyamurthy, L.S.; Bhatia, B.S.; Bhaskarnarayana, A., "Communication satellite based network for telemedicine in India," Enterprise Networking and Computing in Healthcare Industry, 2004. HEALTHCOM 2004. Proceedings. 6th International Workshop on , vol., no., pp.149,151, 28-29 June 2004
[5] F. Lin Lai, X. Shao, R. Kanagasabai "Semantic IPTV Service Discovery System," in IEEE Eighth World Congress on Services, 2012
[6] ITU-T IPTV standard, H.770, "Mechanisms for service discovery and selection for IPTV services ", 2009.
[7] A. los Santos Aransay "Estado del arte en IPTV", Universidad De Vigo: Multimedia E Internet, Junio de 2009
[8] Zeadally, S.; Moustafa, H.; Siddiqui, F., "Internet Protocol Television (IPTV): Architecture, Trends, and Challenges," Systems Journal, IEEE , vol.5, no.4, pp.518,527, Dec. 2011
[9] Vargas, A. "Tecnologia y Arquitectura de las Redes Òpticas GPON" 2009.
[10] A.N Zainal Abidin, W.R Wan Abdullah, A.Ramli, M.Z.M Jenu "Interference Limit Proposal for ADSL2+ Using APD Methodology," Conference on Applied Electromagnetics, 2010
[11] Kiang, Jean-Fu. "Analysis of linear coaxial antennas." Antennas and Propagation, IEEE Transactions on 46.5 (1998): 636-642.
[12] Chen, Walter Y., and Kenneth Kerpez. "Coaxial cable distribution plant performance simulation for interactive multimedia TV." Global Telecommunications Conference, 1995, IEEE. Vol. 1, 1995
[13] Skubic, Bjorn, et al. "A comparison of dynamic bandwidth allocation for EPON, GPON, and next-generation TDM PON." Communications Magazine, IEEE47.3 (2009): S40-S48.
[14] Goncalves, Glauco Estacio, et al. "On the use of an ADSL2+ testbed for video quality assessment." Communications, 2009. ICC'09. International Conference on. IEEE, 2009.
[15] Mikac, Vedran, Alen Bažant, and Z. Ilic. "Downstream bit rate calculation for ADSL2+ loops limited with far-end crosstalk." Software, Telecommunications and Computer Networks, SoftCOM 2007. 15th International Conference on. IEEE, 2007.
[16] Ra, Sang-Jung, Dong-Joon Choi, and Namho Hur. "Design and implementation of 6/12MHz switchable QAM modulator based on DOCSIS 3.0." ICT Convergence (ICTC), 2011 International Conference on. IEEE, 2011.
[17] Sdralia, Vaia. "Optimized recovery of DOCSIS networks using reserved persistent ranging." Global Telecommunications Conference, 2001. GLOBECOM'01. IEEE. Vol. 1, 2001.
[18] DATA, T. & RG6-CATV, S. (1000), 75 Ohm Flexible RG6-CATV Coax Cable Triple Shielded with Black PVC (NC) Jacket, www.pasternack.com.
[19] DATA, T. & RG59, S. (1000), 75 Ohm Flexible RG59 Coax Cable Single Shielded with Black PVC (NC) Jacket, www.pasternack.com.
[20] Selmanovic, F.; Skaljo, E., "GPON in Telecommunication Network," Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT), 2010 International Congress on , vol., no., pp.1012,1016, 18-20 Oct. 2010
[21] Townsley, W., et al. Layer Two Tunneling Protocol'L2TP', August 1999. IETF Request for Comments. RFC 2661.
[22] Specification, Radio Frequency Interface. "Data-Over-Cable Service Interface Specifications. DOCSIS 3.0" CM-SP-MULPI v3.0-I15-110210, 2006.
[23] Fernando Boronat Seguí, Miguel García Pineda, Jaime Lloret Mauri "IPTV: la televisión por Internet"
[24] Jiang, A. L. J.; Hooi, L. C. & Budiarto, R. "Performance of Qos Mechanism for HD IPTV in Jumbo Ethernet Frame Ipv6~Network" Second International Conference on Network Applications, Protocols and Services, IEEE, 2010
[25] Mezzavilla, Marco, et al. "Evaluation of Jumboframes feasibility in LTE access networks." Communications (ICC), 2013 IEEE International Conference on. IEEE, 2013.
[26] D. Borman, S. Deering, and R. Hinden, RFC 2675: Ipv6 jumbograms," 1999. 2.3.2
[27] Rodríguez Bejarano, Ivonne Stephanne. "Análisis del rendimiento a nivel de enlace en los canales Wifi de siguiente generación y gigabit ethernet, para jumbogramas IPV6." (2012).
[28] Lin, S., Costello, D. J., & Miller, M. J. "Automatic-repeat-request error-control schemes." IEEE Communications Magazine, 1985. pp 5-17.
[29] Schwartz, Mischa. Redes de telecomunicaciones: protocolos, modelado y análisis. Addison-Wesley Iberoamericana, 1994.