Adaptive Rate Control With Erlangian For UHD Traffic Over Paralleled DSL

Surasee Prahmkaew

Faculty of Industrial Technology, Phranakorn Rajabhat University
see2744@gmail.com

Abstract: In the Telecommunications network, the bandwidth is the major concerning to deliver quality of service (Qos) especially high definition content. In such a condition, to deliver uncompressed high definition content with paralleled digital subscriber lines is required for the continuous multimedia transmission and most obligations with QoS are submitted by each telecommunication network company. We had been more explored on Adaptive Rate Control (ARC) with Elrangian with multiple sources of UHD video and HD video to be serviced with multiple paralleled Digital Subscriber Lines (PDSL) operators. This research will explore the classical mechanism and adaptive rate control (ARC) with policing mechanism to provide more reliability services. The mean queue time, throughput, and number of sources served in telecommunication network will be collected and compared. In this paper we simulate the application for the multiple of PDSLs to deliver the multiple source types of viedo (UHD and HD) with the best QoS, the performance matrices is evaluated. Finally results were impressive to support by ARC with policing mechanism.

Keywords: Throughput, Mean queue time, DSL, Fragmentation, Erlangian, ARC.

I. Introduction

This research is the extended work of the Performance Evaluation of Adaptive Rate Control over Uncompressed High-Definition Content Transmission with Paralleled Digital Subscriber Lines which is published on the of The Third International Conference on Digital Information, Networking, and Wireless Communications DINWC 2015 [1]. This shown that the HD content grows widely used and believed that is the promising information distribution technology in the future. To handles with the large volume of data, addition bandwidth of transmission channel must be compiled. The PDSL is the simple and worthy solution for the extra bandwidth preparation. The result has shown that the addition bandwidth is varied and ratio to the parallel degree of xDSL channel. Throughput is rising according to the increasing of parallel degree, and turn to stable after reaching the HD input data rate. The network utilization begins from fully utilized and put off proportional to the raising degree of parallel. As a result of additional paralleled channel, traffic load is equally distributed to all paralleled cores then is resulting network utilization factor to drain away. Due to the network utilization, a lot of packet drops occurred when channel usage is full, and the drop rate is drop off when channel usage is loosed. There is nearly no packet drop when the channel bandwidth exceeded the input data rate. Reference [1] show how to obtain the unlimited bandwidth by the parallel technique which is capable with QoS. This technique can adapt to any low cost wireline providers. It also assures that the uncompressed HD content can be broadcasted regardless to the huge data rate required. However, [1] was not investigated the period with highly usage of the Paralleled Digital Subscriber Lines. Then this research will cope with peak rate demand to identify the performance of Adaptive Rate Control (ARC) with policing mechanism to be evaluated with classical mechanism which is able to provide more reliability, utilization, and throughput before served in the wireline providers. It can drop off the packet drop rate by re-injecting the dropped packets into the wireline providers. Channel utilization and throughput will be enlarged, in contrast with the relieving packet drop rate. This paper proposes the Digital Subscriber Lines (DSL) technologies [2] [3] [4] as back bone network to transmit the UHD and HD video to the destination because of its economical, availability, and speedy merit. There are several standards [5] [6] [7] & [8] with variety of data rates and symmetrical characteristics. The VDSL2 [9] is selected for the fundamental structure. It is the newest and the most advanced DSL standard. The Adaptive Rate Control (ARC) with policing mechanism will apply to investigate the performance in throughputs, queue performance matrices and number of source types to deliver. Its compare with classical mechanism when the highly usages period of the paralleled Digital Subscriber Lines (DSLs).

II. The Erlangian traffics in Paralleled Digital Subscriber Lines

One of the high speed DSL technologies which can provide delivery rate up to 52 Mbps for downstream and 23 Mbps for upstream is VDSL [7] with a distance in 1 Km. The other is VDSL2 [9] which extended development from the VDSL. This technology prepare maximum data rate of 250 Mbps over short distance base on theoretical calculation, and then decrease by 50 Mbps in 1 Km distance. VDSL2 serves for application which needed the huge data rate such as High Definition Digital TV or Video transmission. Fig 1. shown the parallel Digital Subscriber Lines (DSL) architecture. Note that the ARC with policing queue represent the entrance of Elrangian traffic to the network while the transit queues will keep all packets transiting the DSL node as the fluctuation of Uncompressed High-Definition Content has arose. In this paper we apply policing mechanism to the input traffic as Voice and Video with high priority to be serviced.

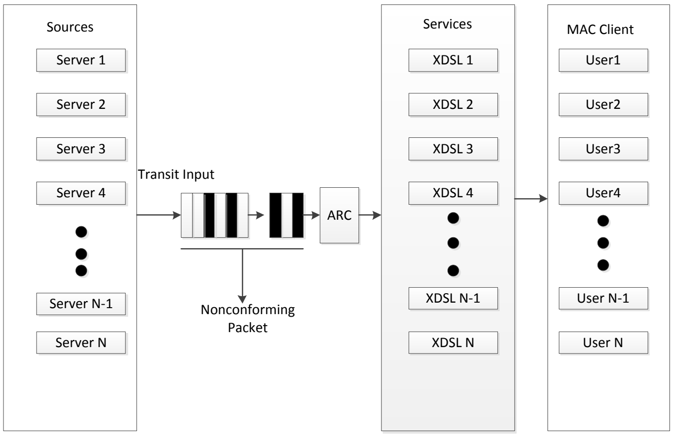


***Fig 1.** Node Architecture in Simulation*

III. ADAPTTIVE RATE CONTROL (ARC) WITH POLICING MECHNISM

High-Definition (HD) denoted as the high resolution information, especially video, but higher resolution than the Standard-Definition (SD). The demand of using multimedia information is needed much more in family applications such as video streaming online, game online, security cameras and video surveillance and etc. Now CCTV application already migrated from the analog camera to HD cameras. This means the 1920x1080 specification directly references the number of individual pixels making up the maximum resolution the camera which can replicate. The more detail that exists in the image results in better overall image quality for our eyes to perceive. In this paper, we assign the input traffic to simulate as uncompressed High Definition content traffic where is 1080p30 with 24-bit colors, that can calculate from the standard equal to 1.5 Gbps Digital Subscriber Line or Digital Subscriber Loop (DSL) is a type of high-speed Internet technology that enables transmission of digital data via the wires of a telephone network. DSL does not interfere with the telephone line; the same line can be used for both Internet and regular telephone services. The download speed of DSL ranges between 384 Kbps and 20 Mbps. There are a lot of DSL standards depending on data rate, distance, and symmetricalness. High bit rate Digital Subscriber Line (HDSL) [13] has a modulation technology similar to Asymmetric Digital Subscriber Line (ADSL) that uses a group of existing copper twisted-pair subscriber telephone lines to transmit data. It offers the data rate of either 1.55 Mbps (T1 rate) or 2 Mbps (E1 rate) symmetrically within 3.6 kilometers distance. Asymmetric Digital Subscriber Lines (ADSL) [14] can transmit more than 6 Mbps to a subscriber. It is enough to provide video-on-demand, and LAN access. In interactive mode it can transmit more than 640 kbps in both directions. This is increasing the existing access capacity by more than fifty-fold enabling the transformation of the existing public network. No longer is it limited to voice, text, and low resolution graphics. It promises to be nothing less than the ubiquitous system that can provide multimedia to entire country. The data rate is now improved to 12 Mbps downstream and 1.3 Mbps upstream within 4 kilometers range. Then, with data compression technique, ADSL2 [11] and ADSL2+ [12] are introduced to increase downstream and upstream data rate to 24 Mbps and 3.5 Mbps respectively. Very-high-bitrate DSL (VDSL) [7] technology operates on a single set of copper twisted pair, and delivers data in the range of 13 Mb/s to 52 Mb/s. This high bandwidth does not come without a price; the range of VDSL is limited to between 0.3 km and 1.4 Km. VDSL2 [8] is developed from the VDSL. It arranged maximum data rate of 250 Mbps over short distance, and drop to around 50 Mbps over 1 kilometer distance. VDSL2 suits for application requiring high data rate such as High Definition Digital TV or Video transmission.

IV. PROPOSED SCENARIO

The result of [1] shown that the additional bandwidth is shrink and expand upon the proportional to the parallel degree of xDSL channel. Throughput is expanding according to the increasing of parallel degree, and turns to stable after reaching the HD input data rate. The network utilization is starting from fully utilized and declined to the proportional of the increasing degree of parallel xDSL. As of extra paralleled channel, traffic load is equally distributed to all paralleled cores resulting network utilization factor to be lower. However in this paper we investigate the parallel of input sources with the period of highly usage the Paralleled Digital Subscriber Lines. Then this research will cope with peak rate demand to identify the performance of the Adaptive Rate Control (ARC) with policing mechanism to compare with classical mechanism From Fig. 2, HD sources are shared equally to the paralleled xDSL channels by ARC. Then, HD traffic are forwarded into each xDSL channel with is assigned base on factor calculation by ARC, and then reach at the subscriber's edge.

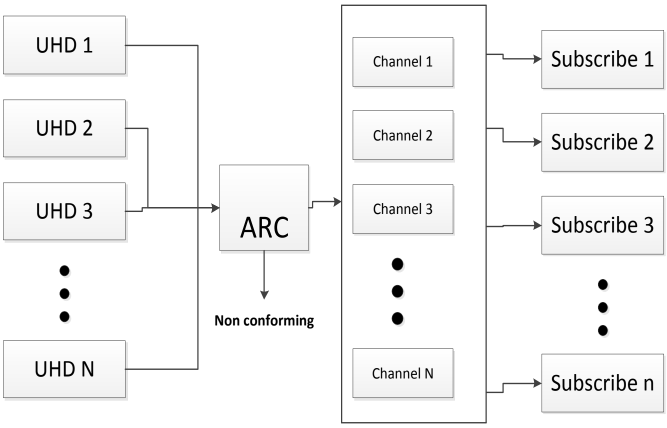


***Fig 2.** Proposed model.*

The proposed model will be applied with M/M/c queue model which is more appropriate in this research and simulation under the following assumptions.

A. Input Traffic

We simulate two input traffic types to simulation, first uncompressed High Definition content traffic 1080p30 and second is same as previous but resolution is 720p30 [15] with all 24-bit colors. The raw data rate can calculate from the standard is approximately 1.5 Gbps and 663 Mbps, respectively. Both types will be injected to the system with N sources. The data rates are, then, applied in the simulation as the n-stage Erlangian arrival in the EZSIM simulator. The probability density function (pdf) of the time spent in the arriving facility will be given by equation 1.

$$A(t) = \left| \frac{n\lambda(n\lambda t)^{n-1} e^{-n\lambda t}}{(n-1)!}, t \geq 0 \right. \quad (1)$$

Where λ can be represent as the mean number of occurrences per time unit.

B. Service Time

The xDSL channel selected for this paper is VDSL2. It has the theoretical maximum data rate of 250 Mbps. The service time calculated from the time which is required to transmit a HD packet. The service time is statistically distributed and modeled as n-stage Erlangian facility in the simulation. Then service times will be given by equation 2.

$$F(x) = \frac{\mu^n x^{n-1} e^{-\mu x}}{(n-1)!}, x \geq 0 \quad (2)$$

Where µ can be represent as the mean number of service per time unit.

C. Channel Bandwidth

Supposed that a paralleled VDSL2 is using in ranged from single VDSL channel to ten VDSLs. It is selected as a communication channels, the channel bandwidth will depend upon the degree of channel duplication. Note that the available bandwidth will be shrinking and expanding between 250 Mbps to 2.5 Gbps.

V. Simulation Results

There are three parameters being explored in the simulation that are 1) Network throughputs, 2) Number of sources and 3) Mean queue time. The network throughput, shown in this paper, is an average rate of successfully delivered UHD and HD content over a paralleled VDSL2 channel(s). Number of sources to be serviced is the type of content to be delivered base on each mechanism. It represent in the total of bit that can be successfully deliver information to the destination base on available channel bandwidth, network traffic in order to the maximum traffic of the network. The mean queue time, shows the level of the packet travel in the system, or simply indicated how "busy" the network is. The simulation results are shown on Fig. 3, Fig. 4, and Fig. 5, accordingly.

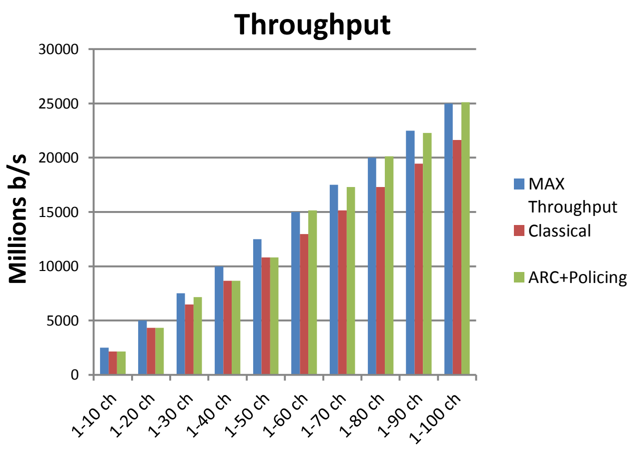
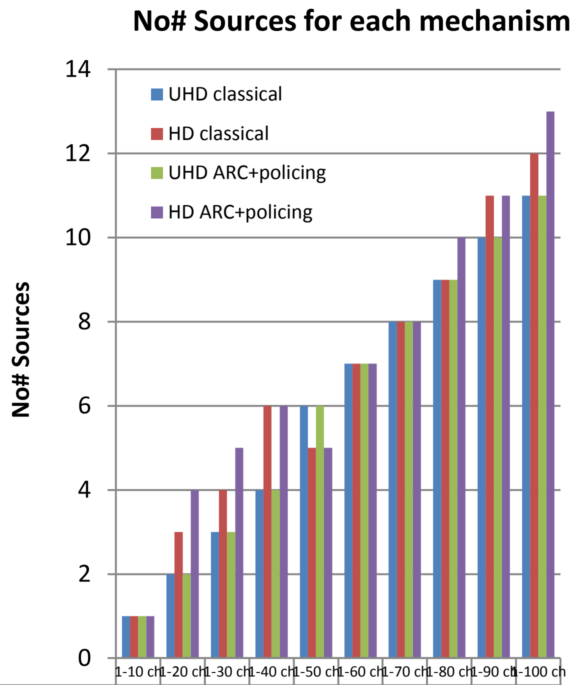


Fig 3. Throughput.



	1-10 ch	1-20 ch	1-30 ch	1-40 ch	1-50 ch	1-60 ch	1-70 ch	1-80 ch	1-90 ch	1-100 ch
UHD classical	1	2	3	4	6	7	8	9	10	11
HD classical	1	3	4	6	5	7	8	9	11	12
UHD ARC+policing	1	2	3	4	6	7	8	9	10	11
HD ARC+policing	1	4	5	6	5	7	8	10	11	13

Fig 4. Type of content to deliver

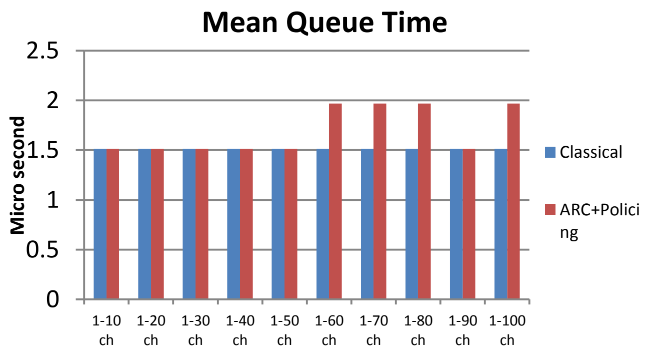


Fig 5. Mean queue time.

From Fig. 3, the classical mechanism will compare with the Max throughput first, at 1-10 channels. We discover that the increasing of number VDSL channels impact to maximum throughput in linearly. We simulate 1 channel to 100 channels for network provider. If we investigate to the throughputs from the input traffic which we injected to system as UHD and HD content, we discover that throughputs are higher according to the additional bandwidth. Next, the UHD traffic is turn to stable at 1.2 Gbps where drop packets are not exit, also starting from six paralleled VDSL2 cores onwards. The reason for this phenomenon is that from that particular point the theoretical maximum network capacity is approaching 1.5 Gbps which is similar to the input HD traffic. Likewise, the HD traffic throughput is also turn to be saturated from the three-paralleled cores subsequently. The theoretical maximum network capacity is around 750 Mbps, which is greater bandwidth than the input HD traffic. After nine paralleled VDSL2, the throughput becomes nearly constant at 2.25 Gbps, the UHD and HD will be smooth transmitted. More about Fig. 3, the ARC+policing mechanism will be well perform at thirty paralleled VDSL2, and sixty to hundred paralleled VDSL2 which is compared to the classical mechanism due to the available of network bandwidth at network provider, the ARC+policing mechanism used store and forward the packet from the other input sources and transmitted to that bandwidth, unlike the other of paralleled VDSL2 (1-10, 1-20, 1-40 and 1-50) which are none of available bandwidth to reuse. Fig. 4 represent the number of each source type that able to be serviced by network provider with base on classical mechanism and ARC+policing. At 1-10, 1-40, 1-50, 1-60, 1-70 and 1-90 paralleled VDSL2, the classical and ARC+policing are preforming equivalent, they can transmit 1 UHD and 1 HD for1-10, 4 UHD and 6 HD for1-40, 6 UHD and 5 HD for1-50, 7 UHD and 7 HD for1-60, 8 UHD and 8 HD for1-70, last 10 UHD and 11 HD for1-90. However, about 1-20, 1-30, 1-80, and 1-100 paralleled VDSL2, ARC+policing is performing better than classical mechanism. It can transmit more input UHD and HD source as show on the table in Fig. 4. Fig. 5, represent the average queue time of the packets which are processing by each mechanism. The ARC+policing mechanism is low performing at 1-20, 1-30, 1-80, and 1-100 paralleled VDSL2 when compared to classical mechanism, the packets spend longer time in the system due to store and forward mechanism by ARC+policing, those packets need to wait to meet the available bandwidth on network provide. However the mean queue time of the ARC+policing mechanism is not exceed the Transport network SLAs for video quality.

Conclusion and Future Works

High Definition information is widely used and turns to be a promising information distribution technology now. To work with the huge amount of data, additional bandwidth of transmission channel must be provided. The paralleled Digital Subscriber Lines is the simple and worthwhile solution for the additional bandwidth preparation. From the simulation, the additional bandwidth is shrinking and expanding to the proportional to the parallel degree of xDSL channel. Throughput is increasing according to the increasing of parallel degree. The classical mechanism is standard performing on network provider. Unlike ARC+policing mechanism is well perform when there are available bandwidth is exiting on network provider. Also the mean queue time of ARC+policing mechanism is higher than classical mechanism when the mechanism found the available bandwidth exit on network provider. The simulation results indicated the very high possibility of acquiring unlimited bandwidth by the parallel technique. The ARC+policing mechanism can be applied to any low cost wireline carrier. It also increase the performance of the network provider to transmit more uncompressed HD content broadcasting and HD content regardless of the huge required data rate.

Acknowledgements

I amre very grateful to Phranakorn Rajabhat University Thailand to supported this research.

References

[1] Surasee Prahmakew, etl "Performance evaluation of Adaptive Rate Control over uncompressed High-Definition content transmission with Paralleled Digital Subscriber Lines",Third International Conference on Digital Information, Networking, and Wireless Communications (DINWC),pp 11-16, Feb. 2015

[2] P.J. Kyees, R.C. McConnell, K. Sistanizadeh, "ADSL: a new twisted-pair access to the information highway," in IEEE Communications Magazine, Vol. 33, Issue 4, 1995, pp. 52 – 60, Apr 1995.

[3] J.M. Cioffi, "Very high-speed digital subscriber lines (VDSL)," in Proceedings of the 23rd European Solid-State Circuits Conference (ESSCIRC '97), 1997, Sep 1997.

[4] W. Walkoe, T.J.J. Starr, "High bit rate digital subscriber line: a copper bridge to the network of the future," in IEEE Journal on Selected Areas in Communications, Vol. 9 , Issue 6, 1991, pp. 765 – 768, Aug 1991.

[5] ITU-T Recommendation G.992.1: Asymmetric digital subscriber line (ADSL) transceivers, Jul 1999.

[6] ITU-T Recommendation G.991.1: High bit rate Digital Subscriber Line (HDSL), Oct. 1998.

[7] ITU-T Recommendation G.993.1: Very high speed digital subscriber line transceivers (VDSL), Apr. 2006.

[8] ITU-T Recommendation G.993.2: Very high speed digital subscriber line transceivers 2 (VDSL2), Feb 2006.

[9] ITU-T Recommendation H.264 : Advanced video coding for generic audiovisual services, Mar 2010

[10] L. Wei, O. Issa, L. Hong, "Evaluation of H.264/AVC error resilience in HD IPTV applications," in IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB), 2010, pp. 1-5, Mar 2010.

[11] I. Eizmendi, G. Prieto, G. Berjon-Eriz, M. Vélez, S. Correia, A. Arrinda, P. Angueira, "HDTV field trials using DVB-T and DVB-T2 broadcasting systems," in IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB), 2010, Mar 2010.

[12] ITU-T Recommendation G.992.3: Asymmetric digital subscriber line (ADSL2) transceivers, Apr 2009.

[13] ITU-T Recommendation G.992.5: Asymmetric digital subscriber line (ADSL2+) transceivers, Jan 2009.

[14] D. Briere, P. Hurley, HDTV for Dummies 2nd edition, 2006.

[15] B. Khoshnevis, Discrete Systems Simulation, McGraw-Hill , 1994.

[16] J. Banks, J.S. Carson II, B. L. Nelson, D.M. Nicol, Discrete-Event System Simulation 4th Edition, Pearson Education International, 2005.