ICCIT

CREATIVE COMMUNICATION AND INNOVATIVE TECHNOLOGY

PERGURUAN TINGGI RAHARJA ACCREDITED

APTIKOM

ASOSIASI PERGURUAN TINGGI INFORMATIKA DAN KOMPUTER

ISSN : 1978 - 8282

PROCEEDINGS

International Conference on Creative Communication and Innovative Technology, 2009 (ICCIT-09)

August 8 th, 2009

go green With Raharja

Endorsed By :

REC ISACA id-SIRTII OCW CONSORTIUM www.ftii.or.id APJII ASPILUKI APKOMINDO MASTEL IPKIN ainaki

Saturday, August 8, 2009

16:25 - 16:45 Room L-212

QoS Mechanism With Probability for IPv6-Based IPTV Network

Primantara H.S, Armanda C.C, Rahmat Budiarto
School of Computer Sciences, Univeristi Sains Malaysia, Penang, Malaysia
prima_at_ub@yahoo.com, armand.caesar@gmail.com, rahmat@cs.usm.my,

Tri Kuntoro P.

School of Computer Science, Gajah Mada University, Yogyakarta, Indonesia
mastri@ugmgtw.ugm.ac.id

Abstract

A convergence of IP and Television networks, known as IPTV, gains popularity. Unfortunately, today's IPTV has limitation, such as using dedicated private IPv4 network, and mostly not considering "quality of service". With the availability of higher speed Internet and the implementation of IPv6 protocol with advanced features, IPTV will become broadly accessible with better quality. IPv6 has a feature of Quality of Service through the use of its attributes of traffic class or flowlable. Existing implementation of current IPv6 attributes is only to differentiate multicast multimedia stream and non multicast one, or providing the same Quality of Service on a single multicast stream along its deliveries regardless number of subscribers. Problem arose when sending multiple multicast streams on allocated bandwidth capacity and different number of subscribers behind routers. Thus, it needs a quality of service which operates on priority based for multiple multicast streams. This paper proposes a QoS mechanism to overcome the problem. The proposed QoS mechanism consists of QoS structure using IPv6 QoS extension header (generated by IPTV provider) and QoS algorithm in executed in routers. By using 70% configuration criteria level and five mathematical function models for number of subscribers, our experiment showed that the proposed mechanism works well with acceptable throughput.

Index Terms— IPTV, IPv6, Multiple Multicast Streams, QoS Mechanism

I. INTRODUCTION

A convergence of two prominent network technologies, which are Internet and television, as known as Internet Protocol Television (IPTV), gains popularity in recent years, as in July 2008 Reuters' television survey reported that one out of five American people watched online television [1]. With the availability of higher speed Internet connection, the IPTV becomes greatly supported for better quality.

IPTV provides digital television programs which are distributed via Internet to subscribers. It is different from conventional television network, the advantage of operating an IPTV is that subscribers can interactively select television programs offered by an IPTV provider as they wish [2]. Subscribers can view the programs either using a computer or a normal television with a set top box (STB) connected to the Internet.

Ramirez in [3], stated that there are two types of services offered to IPTV subscribers. First, an IPTV provider offers its contents like what conventional television does. The IPTV broadcaster streams contents continuously on provided network, and subscribers may select a channel interactively. The data streams are sent in a multicast way. The other one is that an IPTV provider with Video on Demands (VOD) offers its content to be downloaded partly or entirely until the data videos are ready for subscribers to view. The data are sent in a unicast way.

Currently IPTV is mostly operated in IPv4 network and it is privately managed. Therefore, IPTV does not provide "quality of service" (QoS) for its network performance and IPTV simply uses "best effort" [2]. Since the privately managed network offers a huge and very reliable bandwidth for delivering IPTV provider's multicast streams (channels) [4] and IPTV subscribers are located relatively closer to IPTV providers [2], the IPTV network performance is excellent.

In near future, the IPv4 address spaces will be no longer available. Moreover, there is a need to implement "quality of service" as IPTV protocol is possibly implemented in open public network (Internet) rather than in its private network to obtain more ubiquitous subscribers.

The solution to this problem is the use of IPv6 protocol. IPv6 not only providing a lot of address spaces, but it also has more features, such as security, simple IP header for faster routing, extension header, mobility and quality of services (QoS) [5,6]. The use of QoS in IPv6 needs to utilize attributes of flowlable or traffic class of IPv6 header [5]. In addition, since an IPTV is operated as a standard television on which multiple viewers possibly watch the same channel (multicast stream) from the same IPTV service provider, the IPTV stream has to be multicast in order to save bandwidth and to simplify stream sending process. IPv6 is capable of providing these multicast stream deliveries.

In addition to IPTV's unicast VOD deliveries, an IPTV provider serves multiple channels. Each channel sends a multicast stream. On the other hand, IPTV's subscribers may view more than one different channel which can be from the same or different IPTV providers. Therefore, each multicast stream (channel) may have different number of subscribers. Further more, even in a multicast stream, the number of its subscribers under a router and another router can be different.

The use of current IPv6's QoS which employs flowlable or traffic class attributes of IPv6 header is suitable for single multicast stream delivery. Meanwhile, IPTV provider needs to broadcast multiple multicast streams (channels). With regards to the various numbers of subscribers joining multiple multicast streams, then the QoS for each multicast stream would be differentiated appropriately. Thus, the current IPv6's QoS could not be implemented on multiple multicast streams, even though it uses Per Hop Behavior (PHB) on each router [7,8,9]. This is because the multicast stream will be treated a same "quality of service" on each router, regardless the number of subscribers of the multicast stream exist behind routers.

The solution to this problem is to use another mechanism to enable operation of QoS mechanisms for multiple multicast streams with also regards to the number of joining subscribers on the streams. The proposed mechanism utilizes QoS mechanism which implements a new IPv6 QoS extension header (IPv6 QoS header, for short) as QoS structure, and QoS mechanism to employ such algorithm. IPv6 QoS header will be constructed on IPTV provider and attached to every multicast stream packet of data, and QoS mechanism is operated on each router to deal with the packet of data which carry IPv6 QoS header.

The main focus of this research will be on designing QoS mechanism, and evaluating its performance by using NS-3 network simulator with regard to QoS measurement, which includes throughput, delay and jitter [10,11]. To simulate the role of the number of subscribers, five mathematical function models are used.

II. RELATED WORK

IPTV high level architecture consists of four main parts, which are content provider, IPTV service provider, network provider and subscribers [12]. Firstly, a content provider supplies a range of content packets, such as video and "traditional" television live streaming. Secondly, an IPTV service provider (IPTV provider in short) sends its contents to its ubiquitous subscribers. Thirdly, it is a network provider which offers network infrastructure to reliably deliver packets from an IPTV provider to its subscribers. Finally, subscribers are users or clients who access the IPTV contents from an IPTV provider. A typical IPTV infrastructure, which consists of these four main parts, is shown in Figure 1.

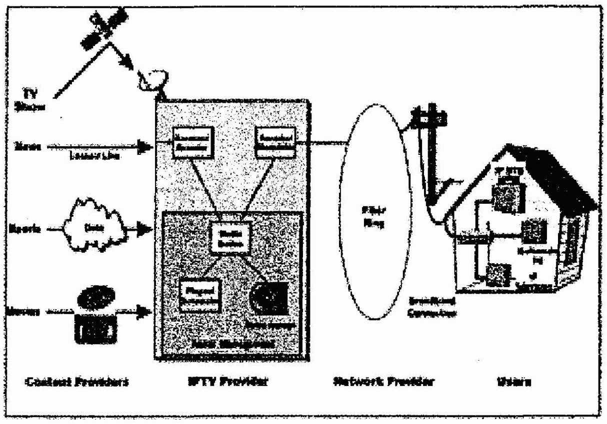

Figure 1. A Typical IPTV Infrastructure [13]

Some researches on IPTV QoS performance and multicast structure have been conducted. An Italian IPTV provider sends about 83 multicast streams [4] on a very reliable network. Each multicast stream with standard video format requires about 3 Mbps of bandwidth capacity [2,4]. Meanwhile, two types of QoS are Integrated Services (IntServ) which is end-to-end base, and Differentiated Services (DiffServ) which is per-hop base [14,15]. A surprising research work on multicast tree's size and structure on the Internet has been conducted by Dolev, et. al. [16]. The observed multicast tree was committed as a form Single Source Multicast with Shortest Path Tree (SPT). The authors significantly found that by observing about 1000 receivers in a multicast tree, the distance between root and receivers was 6 hops taken by most number of clients. The highest distance taken from the observation was about 10 hops.

III. QoS MECHANISM

The proposed QoS mechanism consists of two parts, which are QoS structure as IPv6 QoS extension header and QoS mechanism executed in each router.

III.1 IPv6 QoS Extension Header on Multicast Stream Packet
Each multicast stream's packet of data needs to carry the IPv6 QoS header with the purpose of enabling intermediate routers all the way to reach IPTV's subscribers. The structure of IPv6 QoS header is shown in Figure 2, that also shows the location of the IPv6 QoS header in IPv6 datagram.

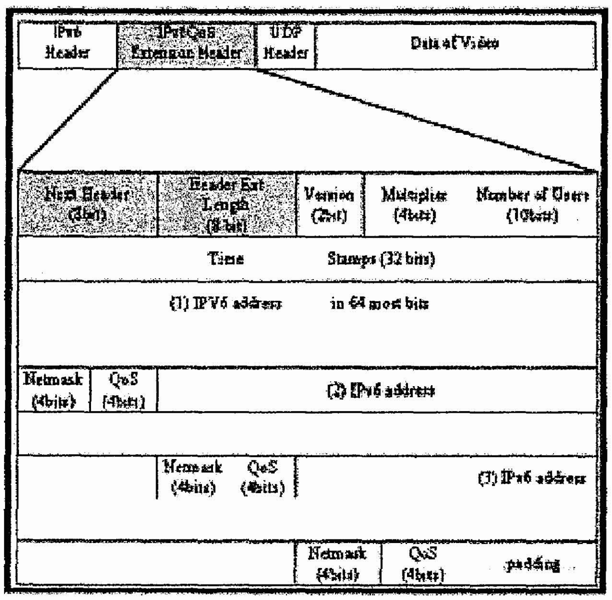

Figure 2. IPv6 QoS extension header

Each IPv6 QoS header, which is derived from standard IPv6 extension header format, maintains a number of QoS value structures. QoS value defines attributes of network address (64 bits), netmask (4 bits) and QoS (4 bit). Network address is an address of the "next" link connected to the router. Netmask is related to network address's netmask. QoS is the value of priority level. This QoS is calculated with formulae in equation 1.

$$QoS_{value} = \left\lfloor \frac{N_{dw}}{N_{tot}} x16 \right\rfloor \qquad (1)$$

where :
N_{dw} : Number of all subscribers only "under" the router
N_{tot} : Number of total subscribers requesting the streams.

Based on these values, an intermediate router knows how to prioritize forwarding an incoming multicast stream with the *QoS value*.

III.2 QoS Mechanism on Intermediate Router
QoS mechanism works as Queuing and Scheduling algorithm to run a forwarding policy to perform DiffServ. Every connected link to a router has different independent queuing and scheduling. Thus, any incoming multicast stream can be copied into several queuing and scheduling process.

The algorithm for queuing and scheduling is composed of three parts as follows.

a. Switching and queuing any incoming stream
This part aims to place the stream into appropriate queue by reading the QoS value in IPv6 QoS extension header. The algorithm for switching and queuing is shown in Figure 3.

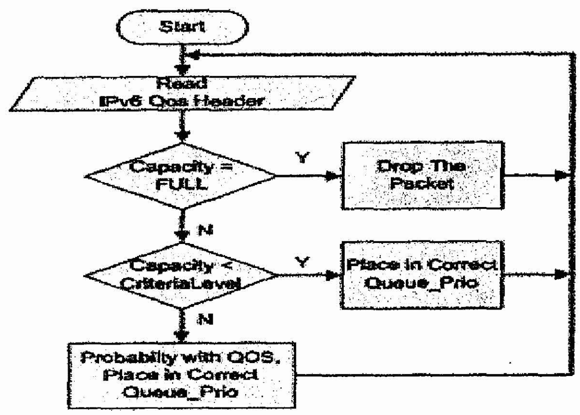

Figure 3. Switching and Queuing Algorithm

b. Queue
Queue consists of N number of queue priority levels. Every level is a queue which can hold incoming multicast stream to be forwarded. The priority queue levels are based on QoS value. These levels are shown in Figure 4.

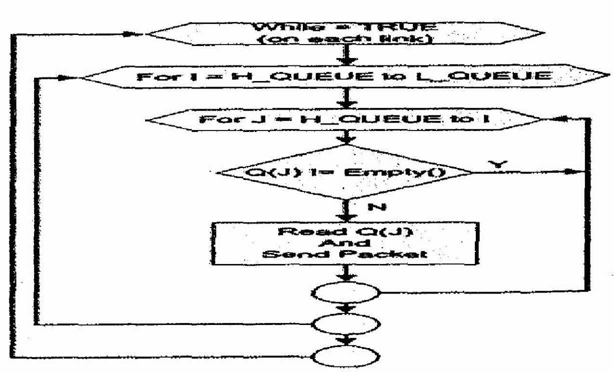

Figure 4. Queue Priority Levels

c. Scheduling

Scheduling for datagram forwarding is to select a queue from which a dequeuing process to forward a queued multicast datagram to corresponding link occurs. The algorithm is shown in Figure 5.

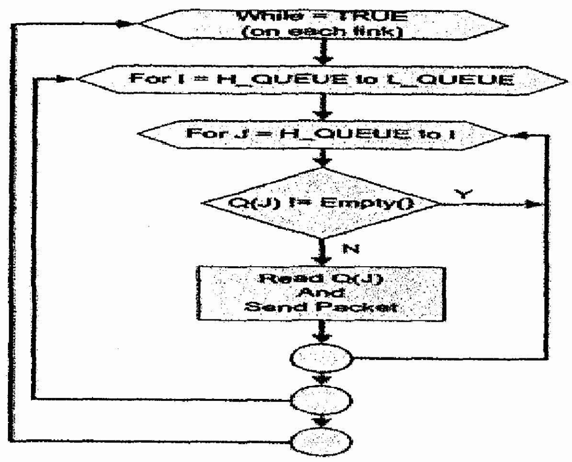

Figure 5. Scheduling Algorithm

IV. ExperimentS

The experiments are conducted by using NS-3 network simulator to measure IPTV performance with regard to QoS measurements (delay, jitter and throughput). However, before doing experiments, some steps are carried out which include configuring network topology, setting up QoS mechanism for each router, and configuring five mathematical function models to represent the models of the numbers of subscribers joining multicast streams.

IV.1 Network Topology

The network topology for our simulation is configured as in Figure 6.

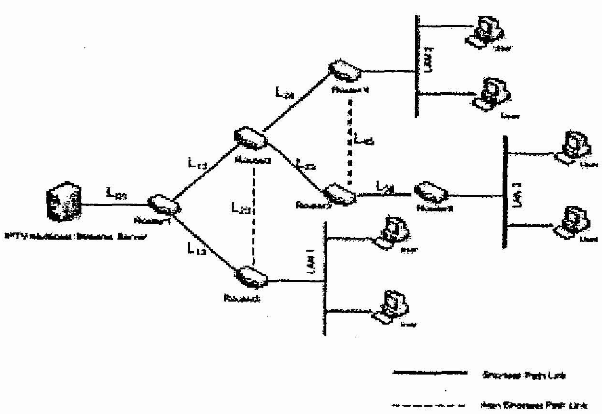

Figure 6. Network Topology

Each link shown in Figure 6 is configured with 150 Mbps, except those which are for local are network (LAN1, LAN2 and LAN3) and L_{01}. Some links are not necessary, as the multicast tree does not create any "loop".

In this simulation, an IPTV Multicast Stream Server generates about 50 multicast streams and 8 unicast traffics to represent IPTV channels and VoDs, respectively. Each multicast stream is generated as constant bit rate (CBR) in 3 Mbps, and also for each unicast traffic as well. Therefore, the total of bandwidth required to send all traffic is greater than the available bandwidth capacities of links. Consequently, some traffic will not be forwarded by a router.

IV.2 Setting Up QoS Mechanism on Routers

Each router in this simulation is equipped with the QoS mechanism configuration. QoS mechanism is composed of 16 QoS priority level queues, or 17 QoS priority level queues if there is unicast traffic which is placed in the lowest level. In addition, Criteria level is set to 70%. It means that if the 70% of total of all queue size is occupied, then the next incoming packet will be placed into appropriate queue priority level based on probability of its QoS value. Ciriteria level 70% is a mix between using priority and probability with a tendency to employ priority mechanism. The 70% criteria level is to show that priority is more important than the probability.

IV.3 Models of the Numbers of Subscribers

The numbers of subscribers for multicast streams to ease the evaluation of QoS measurement are modeled into five mathematical function models. Each model defines how the numbers of subscribers which are represented by QoS priority levels are related to the number of multicast streams. For example, a constant model means each QoS priority level has the same number of multicast streams. For instance, three multicast streams per QoS priority level. Therefore, it would be a total of 48 multicast streams for all 16 QoS priority levels.

Table 1. Five Mathematical Function Models

QOS Priority Level	Number of Multicast Streams (as mathematical function models)				
	Constant	Positive Linear	Negative Linear	Positive Exponential	Negative Exponential
0	3	0	14	0	24
1	3				
2	3	2	12	0	12
3	3				
4	3	4	10	1	6
5	3				
6	3	6	8	2	3
7	3				
8	3	8	6	3	2
9	3				
10	3	10	4	6	1
11	3				
12	3	12	2	12	0
13	3				
14	3	14	0	24	0
15	3				
Total multicast streams	48	56	56	48	48

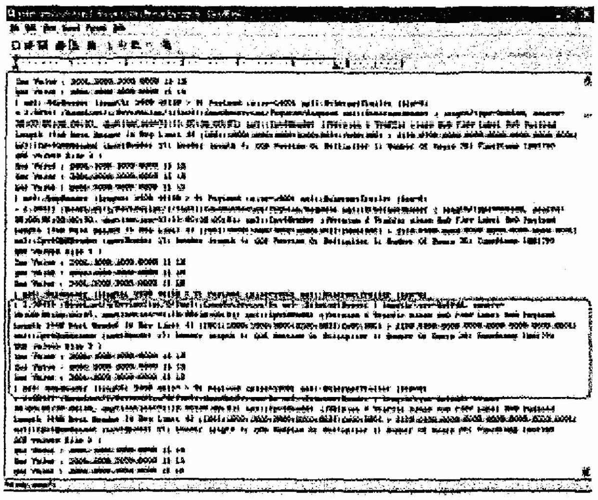

Figure 7. Tracing File of Simulated Network

Other results are based on QoS measurements on a node in nearest network (receiving multiple multicast streams) and a node (receiving unicast streams) in the same network. The results are shown in Figure 8 to Figure 10.

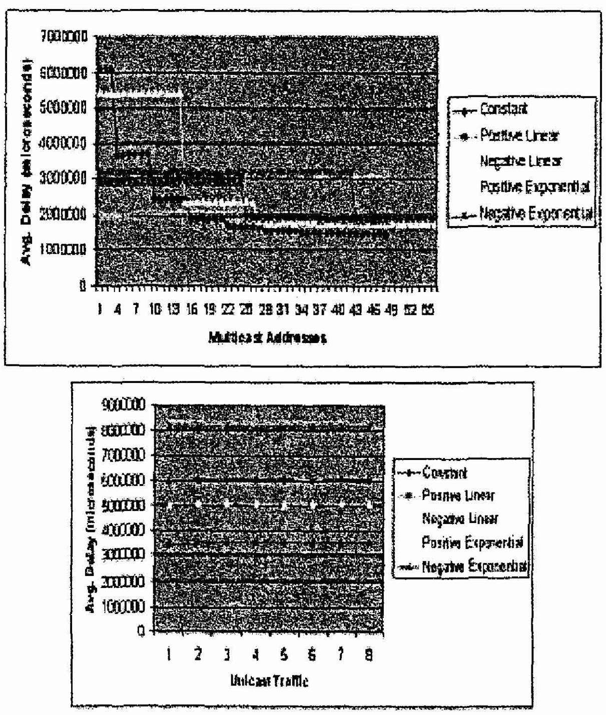

Figure 8. Average Delay of a Node Receiving Multicast Streams and a Node Receiving Unicast Traffic

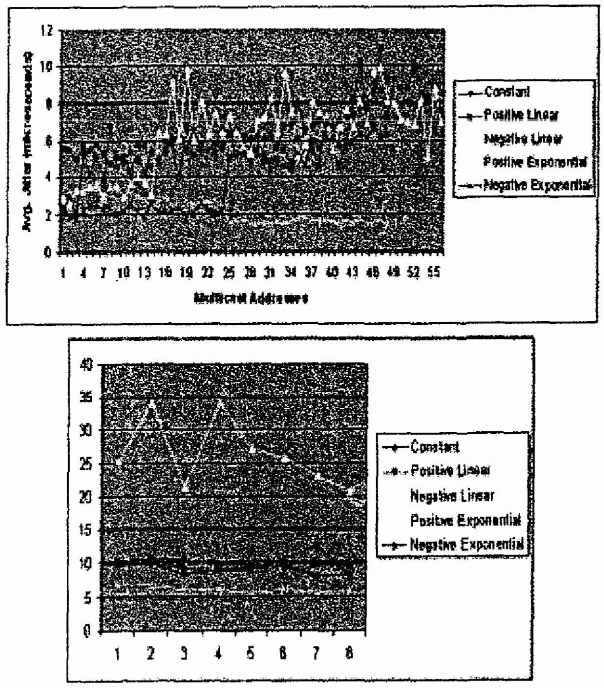

Figure 9. Average Jitter of a Node Receiving Multicast Streams and a Node Receiving Unicast Traffic

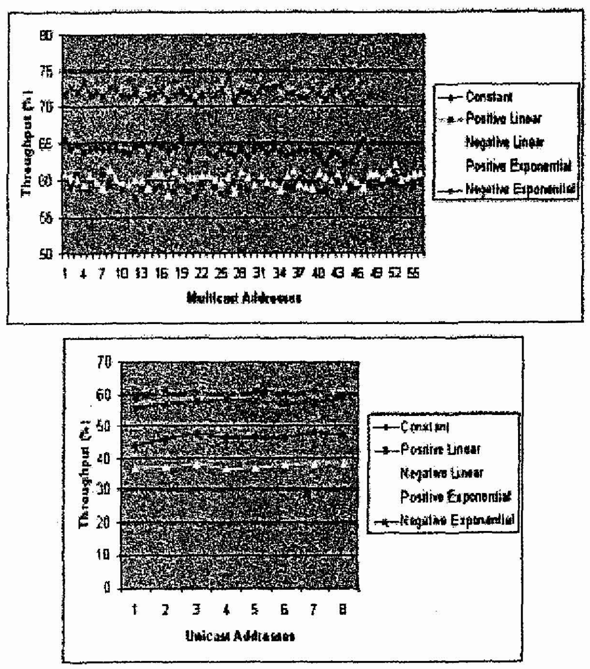

Figure 10. Throughput of a Node Receiving Multicast Streams and a Node Receiving Unicast Traffic

The most important result is throughput, because it is considered the network reliability. Delay and jitter do not considerably disrupt the network; it can be overcome by providing more buffers on subscribers' node.

Throughputs of multicast streams are above 55% and throughputs of unicast traffic are about 35 to 60%. Average delays of multicast streams depend on the mathematical function models, whereas average delays of unicast traffic are almost the same for all unicast traffic. Average of jitter for both types of traffic is relatively low, and less than 50 µs.

VI. CONCLUSION

The proposed QoS mechanism works well as expected. Based on the experiments, with 70% criteria level and five mathematical function models for subscribers, all type of traffic can be successfully forwarded with various throughputs which are about 35% to 74%. However, throughputs of unicast traffic are less than multicast streams, because the unicast traffic is placed into the lowest queue priority level.

References

[1]Reuters, 2008, "Fifth of TV viewers watching online: survey", 29 July 2008, [online], www.reuters.com/article/internetNews/idUSN2934335520080729?sp=true

[2]Weber, J., and Newberry, T., 2007, "IPTV Crash Course", New York: McGraw-Hill.

[3]Ramirez, D., 2008, "IPTV security: protecting high-value digital contents", John Wiley.

[4]Imran, K., 2007, "Measurements of Multicast Television over IP", Proceeding 15th IEEE Workshop on Local and Metropolitan Area Networks.

[5]Hagen, S., 2006, "IPv6 Essential", O'Reilly

[6]Zhang, Y., and Li, Z., 2004, "IPv6 Conformance Testing: Theory And Practice", IEEE

[7]RFC 2597, 1999, "Assured Forwarding PHB Group".

[8]RFC 3140, 2001, "Per Hop Behavior Identification Codes".

[9]RFC 3246, 2002, "An Expedited Forwarding PHB (Per-Hop Behavior)".

[10]Maalaoui, K., Belghith, A., Bonnin, J.M., and Tezeghdanti, M., 2005, "Performance evaluation of QoS routing algorithms", Proceedings of the ACS/IEEE 2005 international Conference on Computer Systems and Applications, January 03 - 06, 2005, IEEE Computer Society.

[11]McCabe, J. D., 2007, "Network analysis, architecture, and design", 3rd ed, Morgan Kaufmann.

[12]ATIS-0800007, 2007, "ATIS IPTV High Level Architecture", ATIS IIF.

[13]Harte, L., 2007, "IPTV Basics : Technology, Operation, and Services", [online] http://www.althosbooks.com/ipteba1.html

[14]RFC 2210, 1997, "The Use of RSVP with IETF Integrated Services".

[15]RFC 4094, 2005, "Analysis of Existing Quality-of-Service Signaling Protocols.".

[16]Dolev, D, Mokryn, O, and Shavitt, Y., 2006, "On Multicast Trees: Structure and Size Estimation", IEEE/ACM Transactions On Networking, Vol. 14, No. 3, June 2006