ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 6, June 2016

Triple Play Services Transmission over Next Generation Mobile Network Using Channel Zapping

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ABSTRACT: The use of Internet Protocol TV (IPTV) deployments in the consumer electronics market is developing among the people in last some years. In IPTV, Quality of Experience (QoE) is very serious factor for end-subscriber satisfaction. Future and available IPTV systems will provide a large no. of channels to subscribers. The most significant factors that have effects on QoE in IPTV systems are channel selection and channel zapping problems. Normally, the channel zapping time is based on various parameters i.e. network delay time, Internet Group Membership Protocol (IGMP) command processing time, IPTV consumer device processing delay time, MPEG decoder time, jitter buffer delay time and Conditional Access/Digital Rights Management (CA/DRM) delay time. In this paper, we improve the throughput of in IPTV systems and we introduce a novel mechanism depending on channel-based peer selection, known as CBPS where the most proper peer to build peer-to-peer (P2P) communication will be found from a look-up table in the central server.

KEYWORDS: Channel zapping times; Peer-to-Peer (P2P) transmission, Quality of Experience (QoE), Internet Protocol TV (IPTV);

I. INTRODUCTION

IPTV deployments become very famous with its benefits in the users electronics market in last some years. IPTV is a novel form of digital television technique. In this system, digital television facilities are provided to consumers throughout a network infrastructure by utilizing internet protocol [1]. IPTV system utilizes the digital video compression method to deliver the multimedia content to end-subscribers. Quality of Experience (QoE) is the most significant factor to fulfill the IPTV consumers. Customers want to use the IPTV channels very frequently and see them to be non-blocking, smooth and without any disturbance. From this point of view, QoE is the most significant parameter for IPTV service suppliers to satisfy. Channel zapping time is assumed as key factor for QoE metric of multicast-based IPTV systems [2]. Channel zapping time can be described as the time difference between the currently seen channel and the display of the first frame of the new required channel by end-subscriber on the TV screen. So thus, the reliable and frequent channel zapping time is the most significant element in validation of QoE in multicast-based IPTV systems. IPTV service suppliers will provide thousands of channels to their consumers.

In the literature review, there are several papers that cover channel zapping times [3-6]. Among the introduced mechanisms in the previous works that we analyzed, various methods from utilizing multiple unicast streams to add adjacent channels [3], employing small Group of Pictures (GOP) size [4], decreasing IGMP command processing delay and predictive tuning by subscriber's channel selection behaviors [5] are showed. In [6], the authors introduced the technique that decreases channel zapping time by forwarding probe message to peers. With respect to this technique, the device that requires channel change will forward to a probe message to other network peers. Then the other peers that see the required channel again will forward a message to channel switched peer. According to this method [6], several messages have to be signaled among peers in the IPTV network at the time of channel change. When it is considering that there will be several peers in IPTV multicast groups, the message signaling technique will not be efficient. If mostly peers in the multicast group perform the channel zapping process at the simultaneously, the message overhead can happen in the system and furthermore a messaging delay during receiving/sending messages among peers will occur. In this paper, we suggest peer-to-peer transmission by CBPS peer selection algorithm among peers in the

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ISSN (Print) : 2320-9798

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IPTV multicast-based system to decrease channel zapping times. With our suggested technique, when the zapping process is began by end-user, if the novel tuned channel is not existed in home gateway (HG), the peer partner between all peers watching the new required channel in the IPTV multicast group will be found by performing channel-based peer selection algorithm and P2P fast communication will be demonstrated between channel switched IPTV user device and it's peer partner to obtain the novel tuned channel. The information about the peer partner that will build a P2P communication with channel zapped device is hold in a look-up table in IPTV central server. When a device begins to zap process, it will provide this information. With the introduced algorithm, the time required for IGMP command buffering and process for the new channel will be eliminated. These operations will be continued in the background and end-subscriber will not wait to process for these. At zapping time, end-subscriber will view the channel from its peer partner. So the channel zapping time will be reduced for IPTV multicast systems to about 1-2 sec. by utilizing our suggested algorithm. In comparison of work in [6], also the messaging overhead in the system will not happen.
The frequent diffusion of high speed internet and the advance broadband networking technology have been breaking down the walls between broadcasting and telecommunication. Internet Protocol Television is one of the main applications in the telecommunication market which provides a chance for telephone companies to advantage from video delivery over IP networks. There are several kinds for IPTV according to the IPTV needs and definition, but four kinds of facilities should be supported in the first phase of IPTV which are VoD (Video on Demand), live TV, TSTV (time-shifted TV) and PVR(Personal Video Recording). Meanwhile the reliability for extending to support other value added facilities /applications may be needed in the future. Four types of role participates the IPTV value chain: Service Provider (SP), Content Provider (CP), Network Operator and Customer. It's sensible that various roles of the IPTV value chain can work independently. Thus, the IPTV architecture should provide support to the functional decomposition for satisfying the needs that various roles of IPTV participate can implement the needs services separately. Security is significant for IPTV. For safeguarding the interests of SP's and CP's, content and service security should be ensured in IPTV system. According to those needs above, an IPTV Architecture is introduced in this contribution. This architecture is consisted of five function sets (sub-systems) involving Service operation, Content Operation and Management, Media Distribution and Delivery, Customer, and System Management and Security [1].
To provide support a scalable IPTV architecture, we require to restrict the needed changes to the server side. However, client-based solutions makes essential the minimum changes at either end point, these solutions can obtain our aims more efficiently as compared to network -assisted and peer-assisted solutions. In this paper, we introduce a client-based solution. Client based solutions basically concentrate on subscriber preferences to decrease the channel switching latency, for example, by generating a prioritized channel listing for the *surfing periods1* to provide concurrent channel change streams to IPTV clients [10]. We can also re-schedule the channel listing at the client side to decrease the no. of switches triggered at the time of a surfing period [11]. Further enhancement to the latency performance is possible by combining the channel reordering idea into a concurrent stream delivery framework [12], since, at the cost of extra overhead in proposed at the client side, and more significantly, at the access network [13]. In this paper, we utilize reordered delivery of time-shifted group of picture (GOP) sequences for the adjacent channels.

II. RELATED WORK

In this paper, we show an efficient IPTV channel reordering algorithm that ensures decreased channel latency with high network usage.

A.Channel Changing Mechanism

It is considered that a subscriber is watching channel #1 and wishes to move to channel #2. Now, the subscriber forwards the channel change message to switch to channel #2 by utilizing a remote controller. Then, STB forwards an IGMP Leave message for channel #1 and an IGMP Join message for channel #2 to HG. As soon as HG obtains the IGMP Leave message, it forwards the IGMP group-specific Query message back to home network and waits for some time. If any reply for channel #1 does not reach, then HG leaves the multicast group for channel #1 by forwarding an IGMP Leave message to the upper-level router. When HG obtains the IGMP Join message for channel #2, it frequently transfers channel #2 to the corresponding STB if already existed. Else, it forwards an IGMP Join message to the upper-level router. These procedures may increase channel change latency.

B. Frequency Interleaved Ordering

In frequency Interleaved Ordering (FIO) mechanism, we randomly re-schedule the channels. Thus the QoE perceived by the client can still change importantly. To enhance the QoE attained by the client, we require decreasing the waiting time for the reliable delivery of the key frame packets, so that the client can arrive its destination earlier.

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III. CHANNEL ZAPPING PROCESS

In the conventional broadcasting facilities i.e. cable or terrestrial, satellite, TV or digital set-top-box can quickly display the chosen channels when the subscriber changes the viewing channel due to all channels are transmitted simultaneously to end-users. Since, in IPTV systems, all channels can't be transmitted to IPTV consumers because of the deficiency of network bandwidth. The increment in uses of several multimedia facilities i.e. pay-per-view (PPV), video-on-demand (VoD) and other unicast video facilities will increase the bandwidth need in network. Thus, the channels bandwidth must be maintained efficiently because every channel requires high-bandwidth [2].

Many IPTV channels are existed at the IPTV customer device but when the consumer chooses the unavailable channel at the IPTV user device, the channel zapping time will be very large in comparison of the channel zapping delays in the conventional broadcasting facilities. So thus, the channel zapping time is taken to be one of the most significant QoE metric in multicast-based IPTV systems.

IPTV Typical Channel Zapping Process

In this section, the channel zapping mechanism for IPTV multicast-based IPTV systems will be described in Fig.1 presents typical channel change method from the currently seen channel (CH1) to newly tuned channel (CH2) in multicast-based IPTV systems. It is considered that a TV viewer views CH1 (channel1) and wishes to change the current channel to CH2 (channel2) by pressing the keys (numerical, electronic program guide, channel up/down etc.) on remote control/keypad of IPTV user device. At this time, firstly IPTV user device forwards IGMP leave message for CH1 to home gateway. As soon as home gateway obtains IGMP leave message, an IGMP Group-Specific Query message is forwarded to home network and waits to receive any response for CH1 from the local group members until the group specific query message's maximum response time. If no reports are obtained from CH1, home gateway blocks the sending of the multicast group for CH1 by forwarding an IGMP leave message to upper level router for the group. After IP-TV consumer device forwards IGMP leave message for the current channel, it forwards an IGMP join message for CH2 to home gateway. When home gateway obtains IGMP join message, if there is no other local hosts that have the group membership, it forwards IGMP join message to upper-level router.

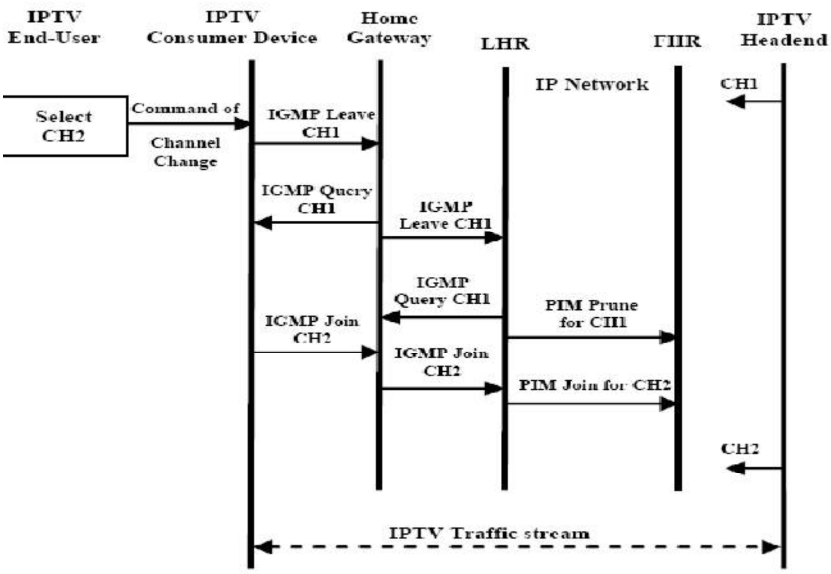

Fig. 1. IPTV channel zapping process (CH1->CH2).

When Last Hop Router (LHR) obtains the join message, it forwards a Protocol Independent Multicast (PIM) Join message to the other multicast routers in the access network. And then the required multicast stream can be transmitted by various routers and home gateway to the IPTV user device [3].

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IV. EXISTING APPROACHES FOR REDUCING CHANNEL ZAPPING TIMES

In this section, the available techniques that are shown in the papers and consumer electronics industry to decrease the channel zapping time in multicast-based IPTV systems will be explained as follows:
A. Using Multiple Streams: This is the most basic technique to decrease channel change delay time. The concept of this technique is top pipe in as many channels as possible to the user premises. This technique success is restricted by the bandwidth existed in access connections [9].
B. Using Adjacent Multicast Join: This method [3] has similar concept with the previous method. This method uses from the idea that the adjacent channels are going to be viewed more quickly by end users. This mechanism manages a table along with the group membership tables and holds track of the adjacent channel requests. It joins non-existent adjacent channels to the program table.
C. Instant Channel Change: This technique is utilized and being marketed by Microsoft TV [9]. This technique utilizes a buffering method. It generates multiple unicast streams that are forwarded to end-subscribers along with the broadcast multicast. This method has critical scalability issue. However, it utilizes unicast stream buffering as the no. of users grows the no. of the stream will increase and will require additional bandwidth in the core network [10].
D. Small GOP Size: This method [4] depends on decreasing the GOP size. A small GOP size can be utilized to decrease the channel change delay. The channel change delay can be decreased further if the transmit rate can be incremented to decrease picture frame obtain time but also small GOP durations decrease the bandwidth efficiency of the encoder resulting higher bit rate for encoded stream.
E. Reducing Video Buffering Time: This solution can be employed at the multiplexer or encoder side of device [4]. The initial video buffering time is very important addition for channel zapping times. But there is trade-off between maximal buffering time and video qualities versus if transport bit rate is static.
F. Predictive Tuning: This method [5] depends on subscriber’s channel selection nature. The primary characteristics of this technique are determining the most effective no. of prior joining channels during zapping and watching period and choosing prior joining channels with joined button-channel preferences.

V. CHANNEL RECORDING IPTV NETWORKS

A basic sequential ordering technique, referred to as the non weighted circular ordering (NWCO) mechanism, would position the most famous session2 next to the least famous one. As a result, the seek distance between the most and the minimum accessed channels would decrease to one at the cost of increased seek distances for the more famous channel switching events. To solve this issue, the writers in [11] introduced a solution, known as the *frequency interleaved ordering* (FIO) mechanism that orders the sessions by disseminating them evenly depending on their access frequencies. To further inquiring our ideas validity, we used a pseudo randomized grouping within the frequency interleaved ordering framework. We indicate the procedure of generating pseudo-randomized groups in Figure 2.

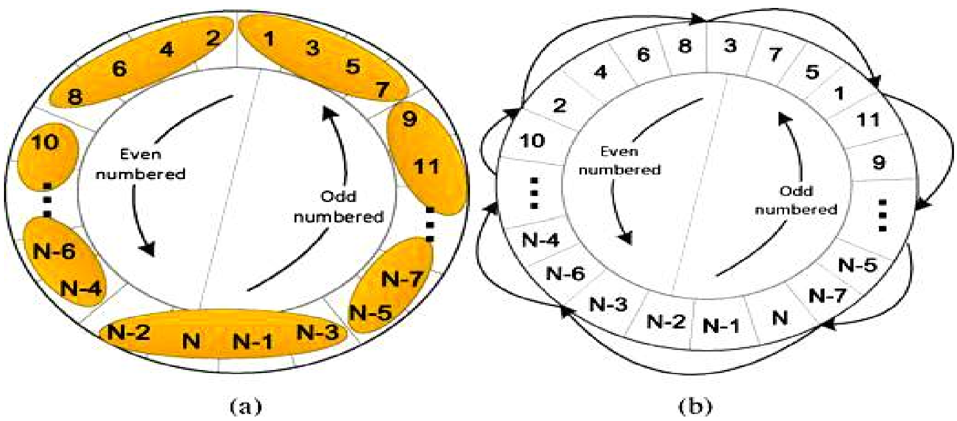

Fig. 2. Frequency interleaved ordering (FIO) with pseudo-random Interleaving When group length *lrg* = 4, (a) FIO, (b) Randomized FIO.

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ISSN (Print) : 2320-9798

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VI. PROPOSED APPROACH

In this section, we suggest peer-to-peer communication between the channel zapping IPTV device and the other peer that will be found by utilizing channel-based peer selection algorithm on IPTV network to solve the problem of IGMP command processing delay at the time of the channel zapping period in multicast-based IPTV systems. To choose the peer partner, a look-up table on the IPTV server will be hold and managed at the regular interval. Then this information will be forwarded to the channel zapped IPTV device at the zapping mode. When it obtains the information regarded to its peer partner that watches the required channel and is in the closest hop count away, the peer-to-peer communication will be begun between channels zapped device and its peer partner. At zapping time, it will receive unicast stream from its peer partner. By this technique, the required time to process IGMP command will be eliminated and so the zapping time will be reduced from 5 sec to 1 sec. Fig. 3 shows the introduced system to decrease the zapping times. In this fig, L1, L2, L3, L4, L5 represents the distance as a hops count among peer-to-peer nodes. Peer selection algorithms are categorized into two classes as global algorithms and user algorithms. The algorithms in the first group will be positioned in receiver side and will run on every peer in the IPTV multicast group or peer-to-peer systems. The second group algorithm will run in centralized server and the peer selection control will be done on server. In our method, we will utilize channel-based peer selection algorithm executing on IPTV central server. In this technique, the channel information on the watching mode and hops count information for every peer in the IPTV network will be gathered in the look-up table as called Dynamic Hash Table (DHT) on the IPTV server. The information about the peers (viewing/zapping/standby mode) mode, the currently viewed channel by the peers in the IPTV network and hops count among nodes will be involved in the table and it will be managed at the regular interval.

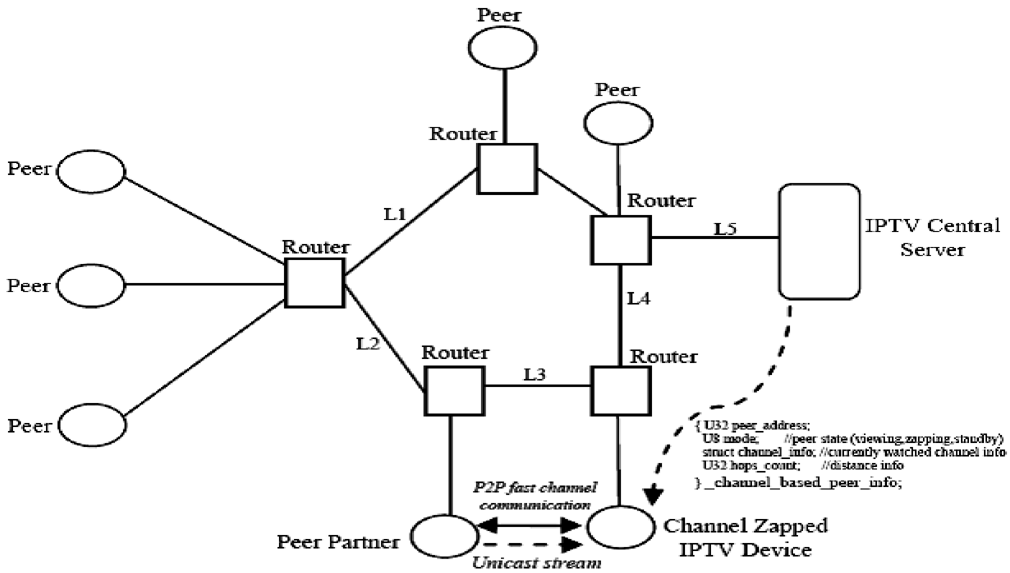

Fig. 3: The proposed system for reducing the channel zapping time

In channel zapping process in IPTV systems, it is considered that TV viewer currently tune the channel1 (CH1) at XXX.XXX.XXX.6 IP multicast address and requests to switch the channel2 (CH2) at the XXX.XXX.XXX.9 IP multicast address. In this situation, IPTV device firstly will forward an IGMP Leave message and then IGMP Join message for new required channel to HG. If the new required channel to tune is not existed in HG, the message involving the information about the peers that watches currently a novel zapping channel will be forwarded to channel zapped IPTV device. In the look-up table on the server, it will be hold the distance information as a hops count for each peer with the channel information.

As soon as the channel switched IPTV device obtains this message involving the peer information that watches currently the required channel and also its distance (for example 2 or 3 hops away) between the channel switched IPTV device and the peer partner, it will attempt to link its peer partner in the novel IP multicast group to build peer-to-peer

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communication with it in zapping process. While zapping mode, the channel switched IPTV device will obtain unicast stream from its peer partner by utilizing the demonstrated IP unicast channel communication. Until the data for the zapped channel to tune from native IP multicast reaches and is buffered well to play, the unicast stream will be obtained from peer partner. When the channel coming IPTV multicast server exist, IPTV user device will began to display it. By utilizing unicast stream for novel required channel from the peer partner, the new channel stream coming from peer partner will be existed very frequently on IPTV device in zapping mode.

In this manner, the IGMP command processing delay problem during channel zapping mechanism will eliminate and so thus channel zapping delay in IPTV multicast systems will be decreased.

TABLE I CHANNEL ZAPPING LATENCY

Channel Change Latency Factors	*Latency (ms)*
Remote control delay	25
Delay for stream to stop	150
Multicast leave old channel	150
Jitter buffer fill	200
Multicast join for new channel	50
I-frame decoding delay	500-2000
CAS/DRM delay	0-2000
Device processing rime	100-200

VII. RESULTS

The figures 4, 5 and 6 show the Throughput of IPTV over Normal Scenario, Throughput of IPTV over Improved Scenario by channel zapping process and Throughput Comparison of IPTV over Improved Scenario respectively. The result also represents that for 70 and 80 km/h, the packet end to end delay, the delay variation, load and delay has equal values. In future, one can examine the IPTV (VOD) over WiMAX by changing various parameters i.e. no. of mobile WiMAX users, network area and power. The average home requires in excess is 50 Mbps to fulfil today's entertainment and communication lifestyle, which is sometimes difficult to ensure even in cities, but more usually in the region with low-density infrastructure telecommunications networks.

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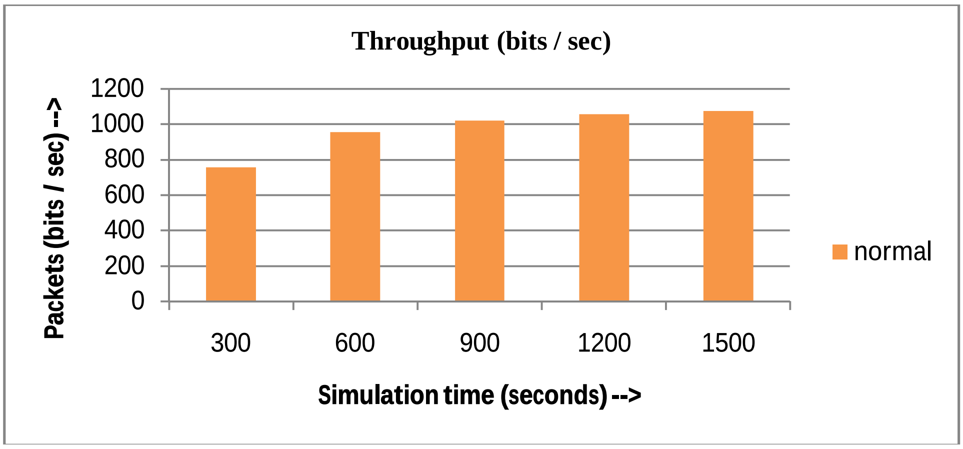

Fig 4 : Throughput of IPTV channel zapping process

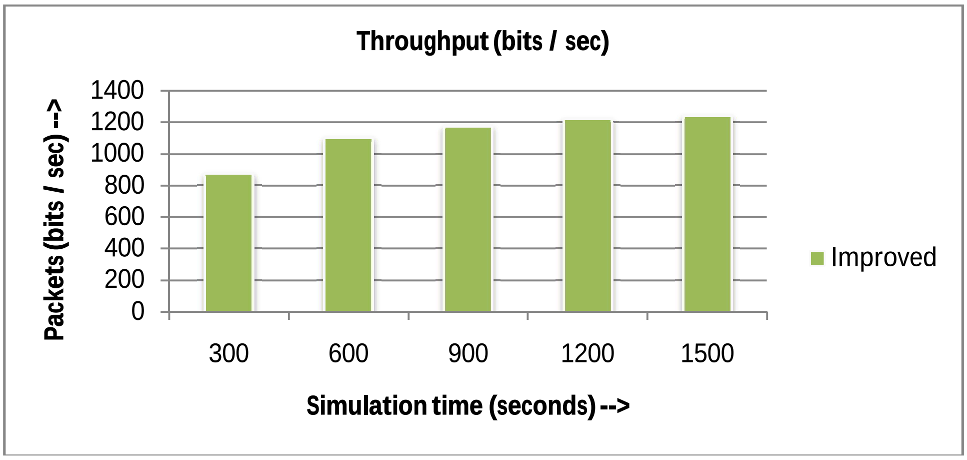

Fig 5 : Throughput of IPTV channel zapping process

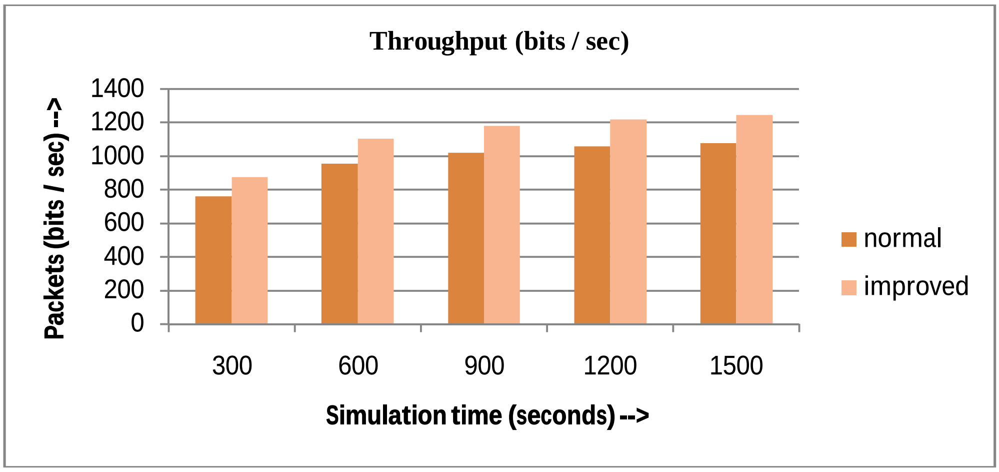

Fig 6: Throughput Comparison of IPTV channel zapping process

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VIII. CONCLUSION

In IPTV multicast systems, channel zapping time or channel switching delay is the most significant key element of Quality of Experience (QoE). To fulfil the IPTV end-subscriber, decreasing channel zapping delay is serious problem that is required to solve by IPTV service suppliers. Channel zapping delay for IPTV multicast facilities should be as short as channel zapping times in conventional broadcasting facilities i.e. terrestrial, cable and satellite.
In this paper, firstly we enquired channel zapping times and channel zapping method in IPTV multicast systems. We showed the elements supporting channel zapping delay and we talked about the available techniques to decrease the channel zapping time. We suggested peer-to-peer communication by finding of peer partner utilizing channel-based peer selection algorithm that is executing on the IPTV central server to eliminate IGMP command delay during channel zapping method and so decrease channel zapping delay. Future work in this area is to decrease the overhead that available in the current reconfigurable channel reordering mechanism. Here, we showed an in-depth analysis of the introduced framework under several scenarios to indicate its robustness and effectiveness.

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