ISSN (Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

Volume 3, Special Issue 3, March 2014

2014 International Conference on Innovations in Engineering and Technology (ICIET'14)
On 21st & 22nd March Organized by

K.L.N. College of Engineering, Madurai, Tamil Nadu, India

Reconfigurable Channel Reordering To Reduce Latency In IPTV Networks

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ABSTRACT— The latency is a critical issue in the Internet Protocol Television (IPTV) Quality of Experience (QoE) and Quality of Service (QoS) performance. Bandwidth limitations prevent the clients from receiving all the channels at once. Latency problem in IPTV networks is reduced by a channel reordering technique that exploits the differing keyframe delivery times for the adjacent sessions to arrange the switching order during the surfing periods. In this paper, we propose the reconfigurable channel reordering technique that adapts itself when a new channel is introduced into the system, without redefining the system. It is efficient in terms of reconfigurable system design with the dynamic channel reordering.

INDEX TERMS — IPTV network, Reconfigurable channel reordering, latency, overhead**.**

I.INTRODUCTION

The rapid diffusion of high speed internet and the advance of broadband networking technology have been breaking down the walls between telecommunication and broadcasting. Internet Protocol Television is one of the key applications in the telecommunication market which gives an opportunity for telephone companies to benefit from video delivery over IP networks. There are various types for IPTV according to the documents of IPTV requirements and definition, but four types of services should be supported in the first stage of IPTV which are live TV, VoD (Video on Demand),TSTV (time-shifted TV) and PVR(Personal Video Recording). Meanwhile the flexibility for extending to support other value added services /applications may be required in the future. Four kinds of role participates the IPTV value chain: Content Provider (CP), Service Provider (SP), Network Operator and Customer. It's reasonable that different roles of the IPTV value chain can operate independently. Therefore, the IPTV architecture should support the functional decomposition in order to satisfy the requirements that different roles of IPTV participates can implement the required functionalities separately. Security is important for IPTV. In order to safeguard the interests of CP's and SP's, content and service security should be guaranteed in IPTV system. According to those requirements above, an IPTV Architecture is proposed in this contribution. This architecture is composed of five function sets (sub-systems) including Content Operation, Service Operation and Management, Media Distribution and Delivery, Customer, and System Management and Security [1].

Reducing the channel change latency is a major design goal for the IPTV service providers to deliver broadcast quality content to IPTV clients [2]. Generally, we can support the latency requirements using three different approaches [3]: (i) content-based solutions that propose modifications on the content being delivered to improve the response time during the channel change phase (e.g., [4],[5]);(ii) network-assisted solutions that typically utilize dedicated servers to promptly service the clients' channel change requests (e.g.,[6],[7]);and (iii) client-based solutions that mostly rely on the modifications dictated at the user side and on the user equipment (e.g., [8], [9]).

To support a scalable IPTV architecture, we need to limit the required changes to the server side. Since client-based solutions necessitate the minimal changes at either end point, these solutions can achieve our objectives more effectively than network -assisted and peer-assisted solutions. In this paper, we propose a client-based solution. Client-based solutions typically focus on user preferences to reduce the channel switching latency, for instance, by creating a prioritized channel listing for the *surfing periods*[1] to deliver concurrent channel change streams to IPTV clients [10]. We can also reorder the channel listing at the client side to minimize the number of switches triggered during a surfing period [11]. Further improvement to the latency performance is possible by integrating the channel reordering concept into a concurrent stream delivery framework [12], however, at the cost of additional overhead introduced at the client side, and more importantly, at the access network [13]. In this paper, we use reordered delivery of time-shifted group of picture (GOP) sequences for the adjacent channels. The basic IPTV service system structure is shown in Fig. 1.

II. RELATED WORK

In this paper, we present an effective IPTV channel reordering algorithm that guarantees reduced channel latency with high network utilization.

A. Channel Changing Mechanism

It is assumed that a user is watching channel #1 and wants to move to channel #2. Now, the user sends the channel change message to switch to channel #2 by using a remote controller. Then, STB sends an IGMP Leave message for channel #1 and an IGMP Join message for channel #2 to HG. As soon as HG receives the IGMP Leave message, it sends the IGMP group-specific Query message back to home network and waits for a while. If any response for channel #1 does not arrive, then HG leaves the multicast group for channel #1 via sending an IGMP Leave message to the upper-level router. When HG receives the IGMP Join message for channel #2, it immediately transmits channel #2 to the corresponding STB if already available. Otherwise, it sends an IGMP Join message to the upper-level router. These processes may increase channel change latency.

B. Frequency Interleaved Ordering

In frequency Interleaved Ordering (FIO) technique, we randomly reorder the channels. Hence the QoE perceived by the client can still vary significantly. To improve the QoE perceived by the client, we need to minimize the waiting time for the reliable delivery of the keyframe packets, so that the client can reach its targeted session sooner.

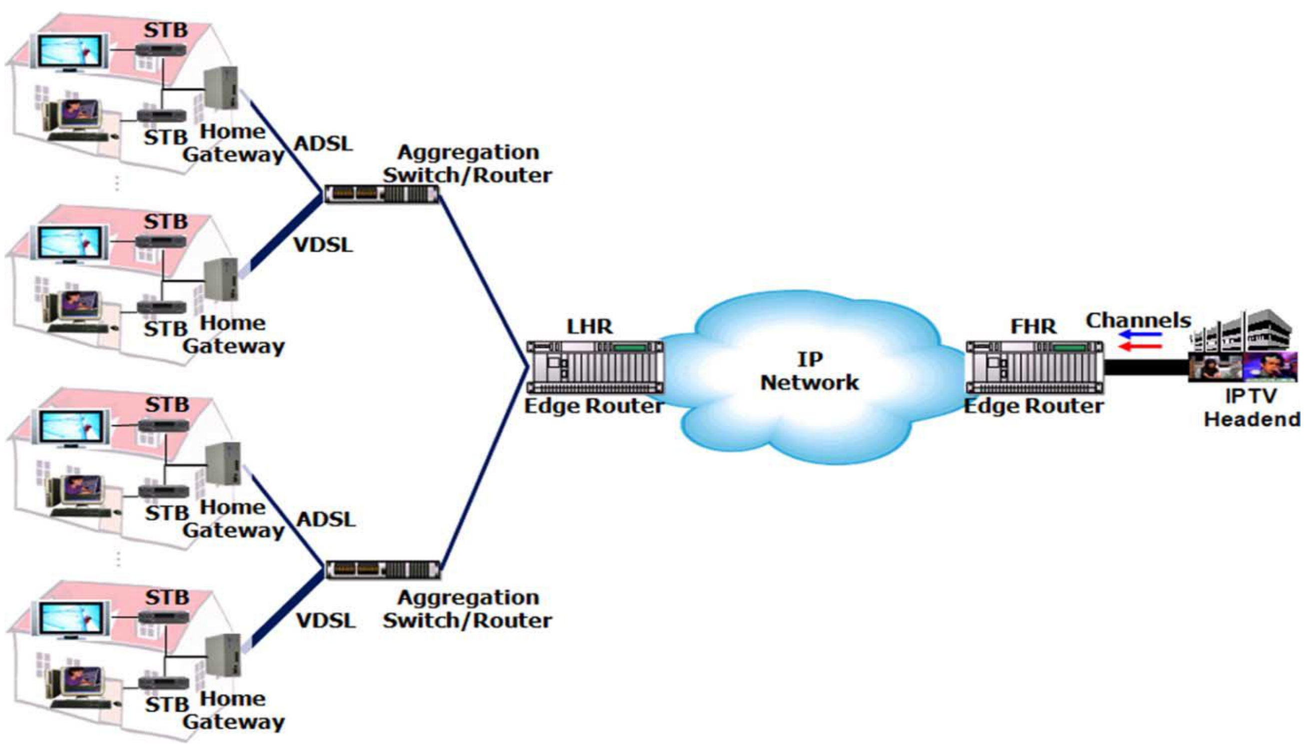

Fig. 1. IPTV service system structure

[2]Hereafter, we will use the terms *channel* and *session* interchangeably, as each refers to the same concept within our framework.

III. Channel Recording iptv Networks

A typical sequential ordering scheme, referred to as the non weighted circular ordering (NWCO) technique, would place the most popular session[2] next to the least popular one. As a result, the seek distance between the most and the least accessed channels would reduce to one at the expense of increased seek distances for the more popular channel switching events. To alleviate this problem, the authors in [11] proposed a solution, referred to as the *frequency interleaved ordering* (FIO) technique that orders the sessions by distributing them evenly based on their access frequencies. To further investigate the validity of our ideas, we employed a pseudo-randomized grouping within the frequency interleaved ordering framework. We show the process of creating pseudo-randomized groups in Fig.2.

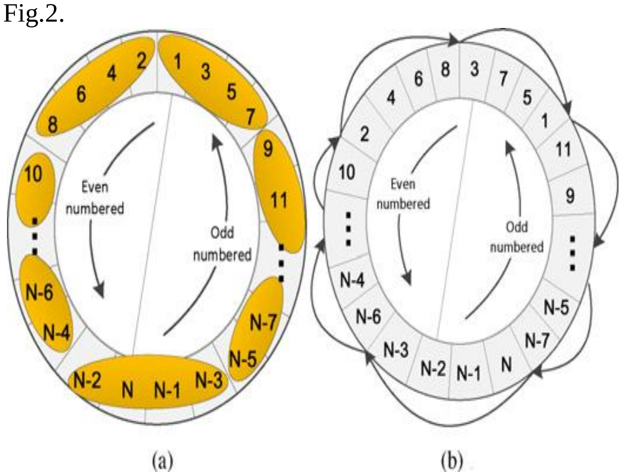

Fig. 2. Frequency interleaved ordering (FIO) with pseudo-random interleaving
When group length *lrg* = 4, (a) FIO, (b) Randomized FIO.

IV. Proposed Reconfigurable Reordering Framework

A. Architecture

We can reduce the latency associated with the key frame delivery by building upon the idea proposed by to develop a reconfigurable channel reordering framework. To support this framework, for each active session, we introduce an intentional time-shift of _T that represents the delay between the adjacent sessions' GOP start times:

[1]*Surfing period represents* the duration in which the client triggers sequential switching events until it settles on a specific channel. Any channel that is accessed by the client in-between *si* and *sj*-along the selected direction of switch-falls within that period where *si*-initial session and *sj*-destination.

$$T_{S,i} = T_{S,i-1} + \Delta T = T_{S,i+1} - \Delta T$$

where $T_{S,i}$ represents the start of delivery time for session S_i's key frame packets and i indicates the assignment order along the circular grid. Here, no additional stream is required to support the channel change process; we can significantly improve the bandwidth efficiency at the access network when compared to techniques that deliver multiple support streams to the clients. The IPTV system architecture is shown in Fig. 3.

The proposed framework utilizes 3variables:
1) The first parameter is ΔT, which represents the separation interval between adjacent sessions based on the original frequency interleaved ordering.
2) The second parameter is ΔW, which represents the maximum waiting period.
3) The third parameter is ΔS, which represents the separation distance between sessions of equal key-frame delivery times. We can find the value of ΔS using the following equation: $\Delta S = TGOP / \Delta T$.

B. Reconfigurable Reordering

Even though the FIO technique proposed in [11] is effective in reducing the number of switches a client has to perform to reach its targeted session, the overall QoE perceived by the client can still vary significantly. That is because; the FIO scheme does not make any prior assumptions regarding the (decoding) characteristics of the delivered sessions.

For our simplified analysis, we make the following assumptions [1]:

1) *TGOP* = 1*s*, the GOP duration is equal to 1 second,
2) *nswitch* = 20, the client makes 20 channel switch requests on average during a surfing period,
3) *Tjoin* = 0.1*s*, average session join latency (based on the Internet group management protocol) is equal to 100 milliseconds,
4) *Tdbuf* = *TGOP/*4, the minimum decoding and buffering latency is equal to 250 milliseconds,
5) After each request the client makes, it waits for the received content to be displayed on the screen before switching to the next session.

Based on these assumptions, we make the following observations:

1) In *the best case scenario*, the client would require $L_{surf,min}$ = 7 seconds to finalize the surfing phase,
2) In *the worst case scenario*, the client would require $L_{surf,max}$ = 27 seconds to finalize the surfing phase.

Therefore, to improve the QoE perceived by the client, we need to minimize the waiting time for the reliable delivery of the key frame packets, so that the client can reach its targeted session sooner. The

Where $L_{surf} = n_{switch} \times (\delta_{wait} + T_{join} + T_{dbuf})$
Where δ_{wait} represents the waiting time for the delivery of the earliest key-frame after joining the session, and its value varies within the interval $[0, T_{GOP}]$ and

$$E[L_{surf}] = (L_{surf,min} + L_{surf,max})/2$$

channel switching in IPTV networks is explained in Fig. 4.

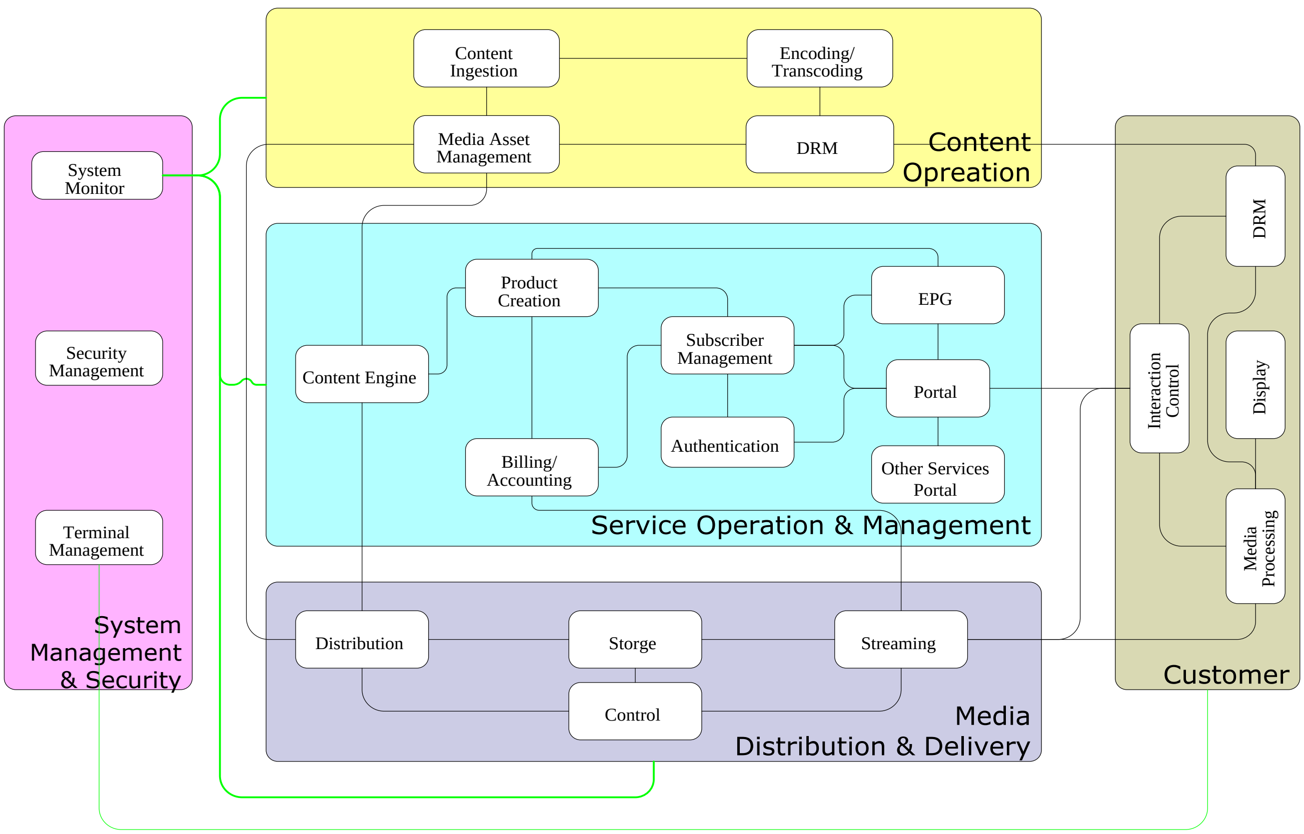

Fig. 3. IPTV system architecture

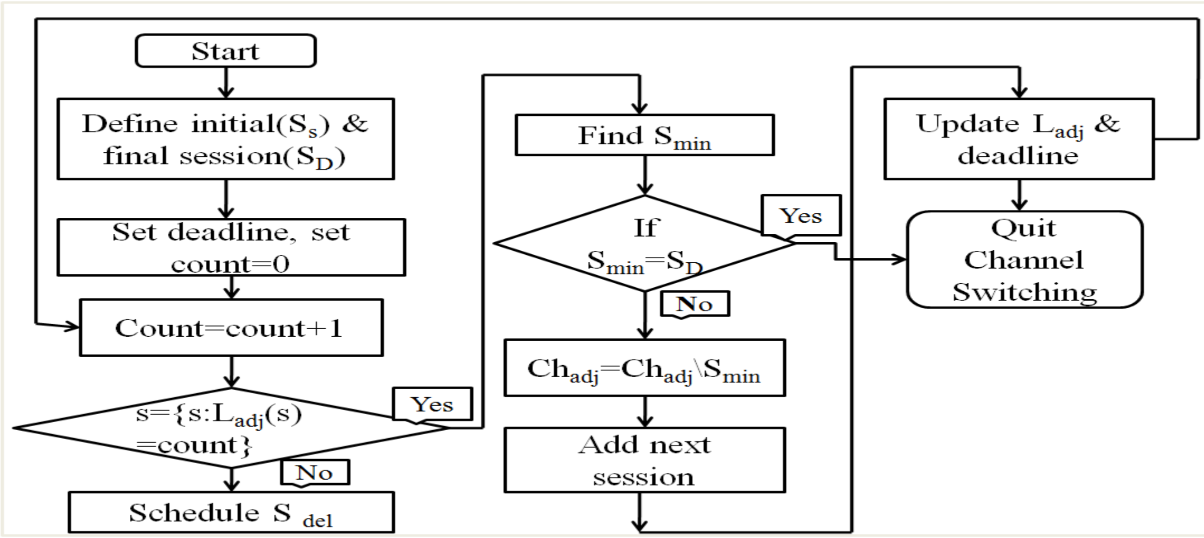

Fig. 4. Channel Switching Mechanism

$Chadj = \{Ch(s + 1), Ch(s + 2), . . . , Ch(s + \Delta S)\}$
Switching deadline for sessions within *Chadj* is *Ladj*
Deadline is from *Chadj* to $O(s) - O(sS) + \Delta W - 1$,
$s_\Delta = \{s : Ladj(s) = cntS\} = \emptyset$,
$Smin = \min[Tkey(s) - (Treq + Tjoin)]$,
T_{req} is the switching time
V. Performance Analysis

A. Simulation Setup

To investigate the performance of the proposed reordering technique, we created a simulation framework to observe for 1×10^6 channel switching events. In these simulations, we put our emphasis on the following performance metrics:
1) *DS*, which represents the number of switching events required to reach the targeted session,
2) $E[LT-SIO]$, which represents the per-switch latency observed during a surfing period, by varying the following parameters:
1) *TGOP*, which represents the GOP duration and is limited to 1 or 2 seconds,
2) *N*, which represents the number of sessions,
3) ΔW, which represents the maximum size for the wait window and is limited to the range [2 − 10], and
4) ΔS, which represents key-frame separation distance between sessions and is typically limited to the range [3 − 6].

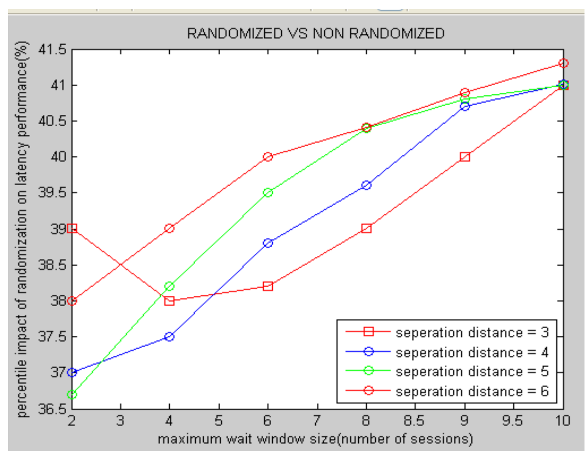

Fig. 5. Randomized Vs Non Randomized

B. Simulation results

We have simulated the results for improving the latency performance for varying separation distance. We improved the latency performance by 30-40%. The randomized Vs non randomized plot is shown in Fig. 5.

The output for the Percentile improvement in latency is shown in Fig. 6. And the latency Vs changes in window size is shown in Fig. 7.

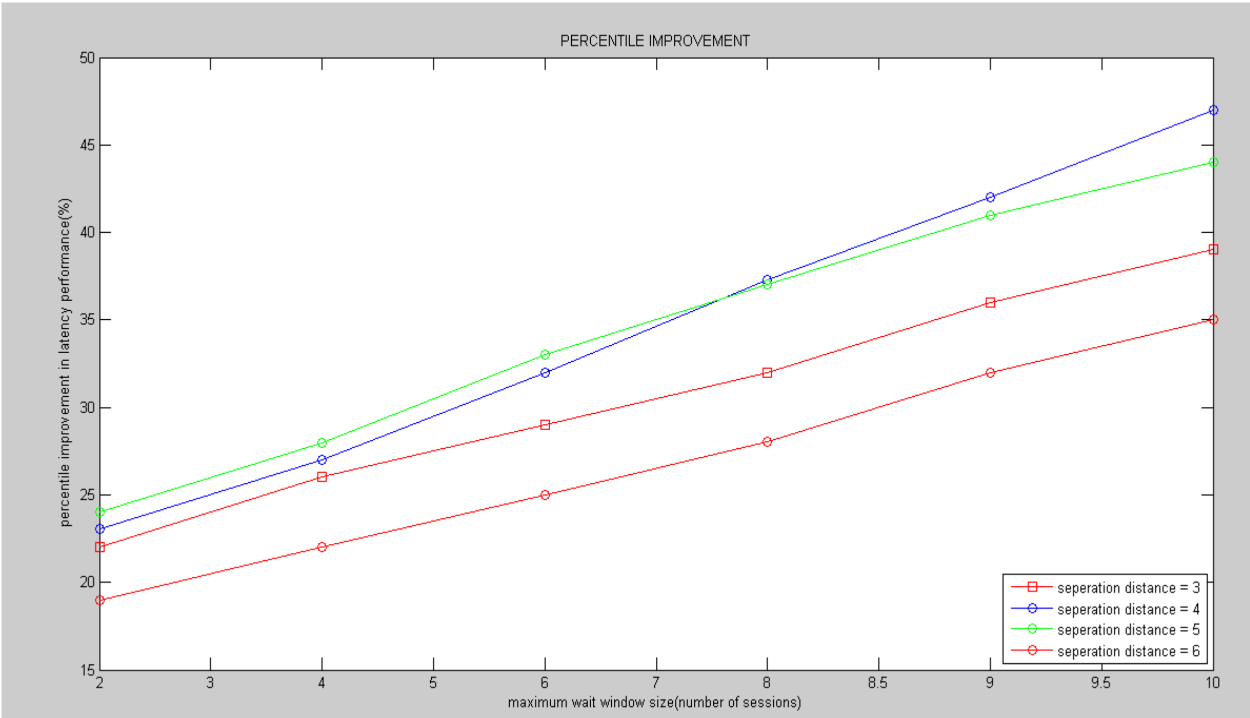

Fig.6. Percentile improvement in latency performance vs maximum wait window size

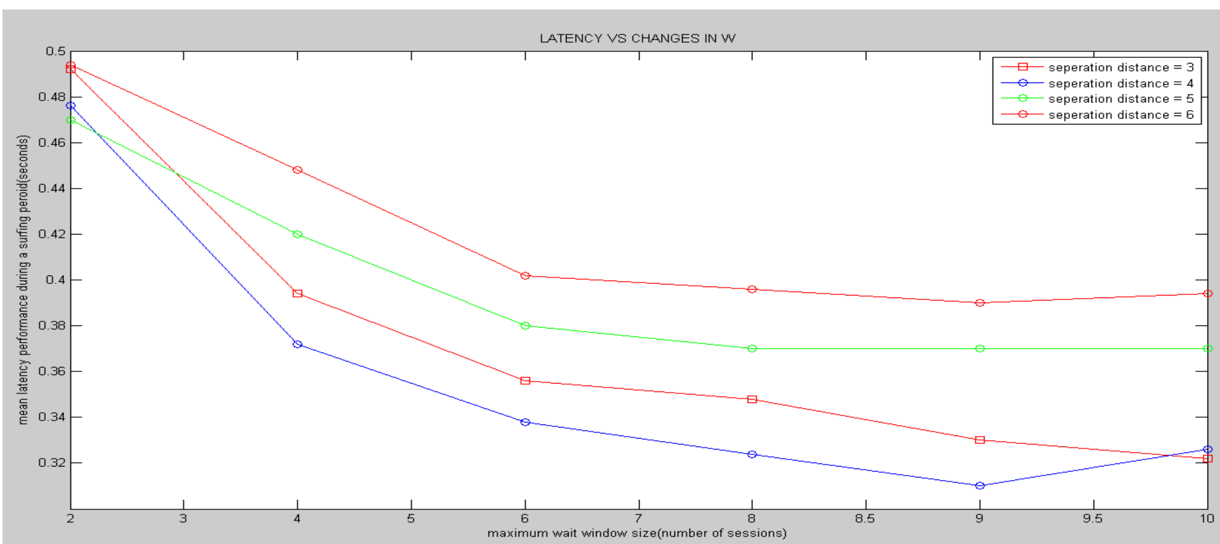

Fig.7.Mean latency performance vs number of sessions

IV.CONCLUSION

Thus the reconfigurable channel reordering technique helps to reduce the latency. Here introduction of new channel is made easy and no further system redesign is required at the server side. Reduced latency is achieved with no additional overhead introduced. The latency performance for different channel ordering schemes is simulated using MATLAB and the output is plotted.

Future work in this field is to reduce the overhead that exists in the current reconfigurable channel reordering technique. Here, we presented an in-depth analysis of the proposed framework under various scenarios to show its effectiveness and robustness.

REFERENCE

[1]Focus Group on IPTV, ”IPTV architecture”, in ITU 1st FG IPTV meeting at Geneva 10-14 July 2006.
[2] [2] J. Asghar, I. Hood, and F. L. Faucheur, “Preserving video quality in IPTV networks,” *IEEE Trans. Broadcast.*, vol. 55, no. 2, pp. 386–395, Jun. 2009.
[3] P. Siebert, T. N. M. V. Caenegem, and M. Wagner, “Analysis and improvements of zapping times in IPTV systems,” *IEEE Trans. Broadcast.*, vol. 55, no. 2, pp. 407–418, Jun. 2009.
[4] J. M. Boyce and A. M. Tourapis, “Fast efficient channel change [set-top box applications],” in *Proc. IEEE Int. Conf. Consumer Electron.*, Jan. 2005, pp. 1–2.
[5] U. Jennehag, T. Zhang, and S. Pettersson, “Improving transmission efficiency in H.264 based IPTV systems,” *IEEE Trans. Broadcast.*, vol. 53, no. 1, pp. 69–77, Mar. 2007.
[6] N. Degrande, K. Laevens, D. D. Vleeschauwer, and R. Sharpe, “Increasing the user perceived quality for IPTV services,” *IEEE Commun. Mag.*, vol. 46, no. 2, pp. 94–100, Feb. 2008.
[7] Y. Bejerano and P. Koppol, “Improving zap response time for IPTV,” in *Proc. IEEE INFOCOM*, Apr. 2009, pp. 1971–1979.
[8] C. Cho, I. Han, Y. Jun, and H. Lee, “Improvement of channel zapping time in IPTV services using the adjacent groups join-leave method,” in *Proc. IEEE Int. Conf. Adv. Commun. Technol.*, vol. 2. Feb. 2004, pp. 971–975.
[9] J. Lee, G. Lee, S. Seok, and B. Chung, “Advanced scheme to reduce IPTV channel zapping time,” in *Managing Next Generation Networks and Services* (Lecture Notes Computer Science, vol. 4773). Berlin, Germany: Springer, 2007, pp. 235–243.
[10] W. Sun, K. Lin, and Y. Guan, “Performance analysis of a finite duration multichannel delivery method in IPTV,” *IEEE Trans. Broadcast.*, vol. 54, no. 3, pp. 419–429, Sep. 2008.
[11] E. Lee, J. Whang, U. Oh, K. Koh, and H. Bahn, “Popular channel concentration schemes for efficient channel navigation in Internet Protocol Televisions,” *IEEE Trans. Consumer Electron.*, vol. 55, no. 4, pp. 1945–1949, Nov. 2009.
[12] U. Oh, S. Lim, and H. Bahn, “Channel reordering and prefetching schemes for efficient iptv channel navigation,” *IEEE Trans. Consumer Electron.*, vol. 56, no. 2, pp. 483–487, May 2010.
[13] A. Azgin and Y. Altunbasak, “Analyzing performance tradeoffs for the delivery of concurrent channel change streams to enable fast channel change in IPTV networks,” in *Proc. IEEE Consumer Commun. Netw. Conf.*, Jan. 2012, pp. 116–121.
[14] A. Azgin and Y. Altunbasak, “Dynamic channel reordering to reduce latency during surfing periods inIPTV networks,” in *Proc. IEEE Consumer Commun. Netw. Conf.*, Sep. 2013, pp.471-483.