A Channel Management Framework to Construct User Preferred Fast Channel Change Stream in IPTV*

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Abstract. This paper proposes an effective channel management framework which analyzes the user channel surfing behavior and constructs fast channel change stream consisting of user preferred channels. The usual channel delay is obliterated if the user requested channel is found at the Set-Top-Box (STB).

Keywords: IPTV Channel Change, Channel Management.

1 Introduction

IPTV is one of the most upcoming killer applications among the next generation Internet applications. Due to the bandwidth constraint of access network it is impossible to supply all channels to the user premises (i.e. STB). Therefore channel zapping delay is inevitable if the channel is not fount at STB. There are two major strategies "(i) to increase the number of I-frames to reduce decoding delay [1][4] and (ii) to ensure channel availability at STB [2][3]" observed in the contemporary research works to reduce channel zapping delay. Considering usual the notion of human being, it is very evident that user's choice in a locality does not vary rapidly. Therefore, ensuring the availability of user preferred channels at STB certainly reduces channel zapping delay. In this paper we propose a framework to acquire channel surfing behavior and an algorithm to mine user preferred channel sequence to reduce channel zapping delay.

2 Proposed Channel Management Framework

Our basic idea (Fig. 1(a)) is to supply as many channels as possible at the STB based on available bandwidth. To analyze users channel surfing behavior and to prepare the list of preferred channels we need (i) a data collection framework and (ii) channel mining algorithm.

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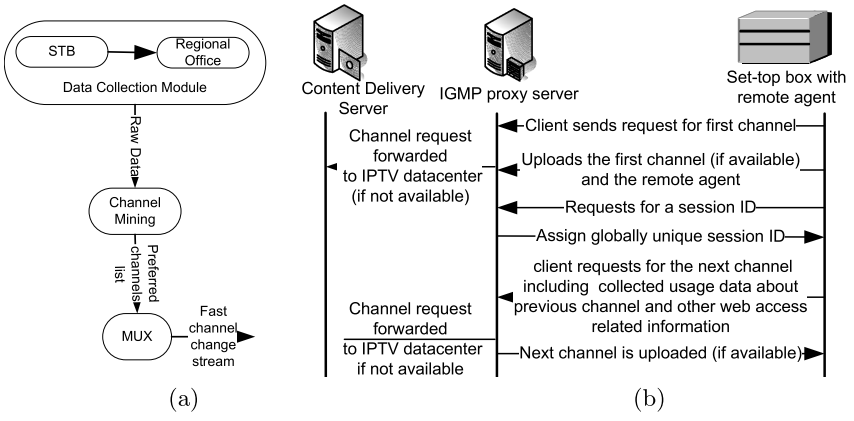


Fig. 1. (a) Overall architecture of the proposed channel management framework (b)Usage data collection

(i) Usage Data Collection Framework: This component is responsible for collecting channel usage data e.g. channel surfing, view time, etc. of the end users. Proposed data collection framework has following two components:

- **STB Agent:** Remote agent resides in the end user's set-top box and supplies load-time, unload time, view-time, etc. Each remote agent is assigned with a unique ID by the usage-data-collector to accumulate the channel usage behavior statistics. As the agent runs at the client's end it must be light and maintain user privacy.
- **Usage-Data-Collector:** Usage-Data-Collector is the module to receive information from the remote agent and directly dump into the database. The operations between STB agent and usage-data-collector are described in Fig. 1(b).

(ii) Channel Preference Mining Algorithm: In this section we present utility based channel mining algorithm where utility represents the significance of a particular/group of channels viewed by the end user in terms of viewing length and frequency.

- **Objective value**[$\mathbf{O}(ch_i, T_j)$] We define the objective value of ch_i in transaction T_j in the database as a temporal feature. Therefore, it indicates amount of time that a channel is viewed in a particular session.
- **Subjective value** [$\mathbf{S}(ch_i, T_j)$] It is defined as the spatial feature and indicates the number of times the channel ch_i is viewed in transaction T_j. In other words it is the viewing frequency of a particular channel for a session.
- **Utility Function** [$\mathbf{U}(ch_i, T_j)$] Basically utility function is defined as a function of two real numbers and through any basic operation it produces another positive real number. In our channel mining algorithm we define utility function as the multiplication of subjective and objective value, formally,

$$U(ch_i, T_j) = O(ch_i, T_j) \times S(ch_i, T_j) \tag{1}$$

It is very evident that we can obtain channel preference for a particular transaction in terms of temporal and spatial significance from an end user point of view. Note that the amount of channel to be supplied to the user STB depends on the bandwidth of the access link. Therefore, number of preferred channels to be obtained from the mining algorithm is restricted by the total bandwidth. Let b_{link} be the bandwidth of the access link, so the number of channels to be supplied to the end user can be calculated as:

$$num(ch) = \frac{b_{link}}{b_{ch}} \tag{2}$$

Where $num(ch)$ is the total number of channels that can be supplied to the STB and b_{ch} is the bandwidth required to serve one channel. After obtaining $num(ch)$, our framework executes the following algorithm to determine the list of preferred channels P_{ch} for a particular user.

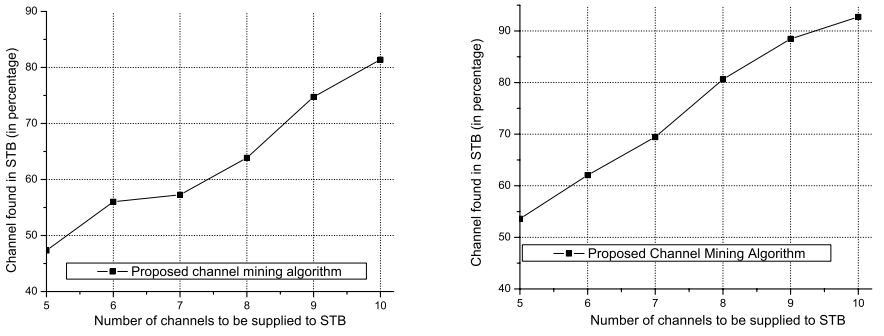
Channel Mining Algorithm

Input:set of transactions T_1, T_2, T_3....T_n for a particular user
Output: set of preferred channels P_{ch}
var: $P_{ch} = 0, C_{ch} = num(ch), max = 0$
1. **for each transaction** T_1, T_2, T_3....T_n
2. $U(ch_i, T_j) = O(ch_i, T_j) \times S(ch_i, T_j)$
3. **end for**
4. **for each transaction**T_1, T_2, T_3....T_n
6. $U(ch, T_j) = \sum U(ch_i, T_j)$ $ch_1, ch_2...ch_n \in C_{ch}$
7. **if** $(U(C_{ch}, T_j) \geq max$
8. $max = U(C_{ch}, T_j); P_{ch} = C_{ch}$
7. **end if**
8. **end for**

The algorithm provides a set of channels having highest utility value. IPTV distribution router multiplexes preferred list of channels obtained from the channel mining algorithm and supplies to the end user's STB. If an end user switches channel within the preferred list i.e. cache hit, the channel can be immediately viewed without any zapping delay.

3 Performance Evaluation

To evaluate the performance of the mining algorithm we have performed simulation in C++. We have considered 30 channels, 15 users and each user channel surfing behavior is analyzed for last 50 transactions in the database. We have generated the channel surfing sequence with a random number and viewing time of each channel is also generated using a random number between 1 to 120. It is to be mentioned that viewing time is measured in 'minute' time unit. Figure 6



(a) (b)

Fig. 2. Channel availability at STB: (a)15 user and (b)10 user

shows channel availability at STB based on our channel mining algorithm. From the result (Fig. 6 (a)) it is evident that channel availability increases if we can supply more channels to STB. Also, channel surfing behavior varies with the amount of user. As Fig. 6(b) shows channel availability with 10 users are more than channel availability with 15 users.

4 Conclusion

Most of the client/end user has a list of favorite channels that he/she watches often and cycles through. Therefore, channel preference mining is of enormous importance in IPTV environment. In this paper we introduce a preliminary idea i.e. utility based channel mining algorithm. In future we would like incorporate statistical measures with the utility mining to obtain higher hit ratio of the user requested channel at the STB.

References

1. Joo, H., Song, H., Lee, D.B., Lee, I.: An effective IPTV channel control considering channel zapping time and network utilization. IEEE Transaction on Broadcasting 54(2), 208–216 (2008)
2. Cho, C., Han, I., Jun, Y., Lee, H.: Improvement of channel zapping time in IPTV services using the adjacent groups join-leave method. In: 6th International Conference on Advanced Communication Technology, vol. 2, pp. 971–975 (2004)
3. Jieun, L., Geonbok, L., Seunghak, S., Byngdeok, C.: Advance scheme to reduce IPTV channel zapping time. In: Ata, S., Hong, C.S. (eds.) APNOMS 2007. LNCS, vol. 4773, pp. 235–243. Springer, Heidelberg (2007)
4. Jennehag, U., Pettersson, S.: On Synchronization Frames for Channel Switching in a GOP-Based IPTV Environment. In: 5th IEEE Consumer Communications and Networking Conference, CCNC, pp. 638–642 (2008)