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MEASURING THE DELAY IN CHANNEL SWITCHING AND ITS OPTIMIZATION IN IPTV NETWORKS BY PRE-JOINING METHOD OF TV CHANNELS

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ABSTRACT

Providing television services over IP networks is a very attractive offer. As a new source of revenue offers for network operators, IPTV offers greater flexibility to network operators and provides a wide range of applications for users. to compete in this market, IPTV operators must guarantee at least the same quality of experience in this respect one of the main concerns is to delay in channel switching which is known as zapping delay zapping time in an IPTV network may be last 2 seconds or more Many efforts to reduce the channel switching delay has been done in IPTV network, One of these methods is the predictive adjustment which is called pre-joining. In this way with any request for watching the favorite TV channel, not only the desired channel stream, but also some other channels are added and sent to the client. However, it is required to use more bandwidth on the network. In this study an improved predictability adjustment is researched, the behavior of the user channel selection with SEMI-MARKO process is analyzed and we can estimate the average time of channel change and the average used bandwidth. The optimum number of pre-joining channels in a periodic time is also checked. For the accuracy of selection a simulation is done. Studies show that the proposed method leads to less time to change the channel with the least available bandwidth.

KEYWORDS: *Zapping Time, Channel Selection Behavior, IPTV, Pre-joining Channels.*

I. INTRODUCTION

IPTV is one of the key applications in the communications world that Provides an opportunity for telephone companies to use the delivery of video over IP networks, in other words IPTV is transmission and broadcast of television programs to subscribers through broadband infrastructure and the IP protocol, Due to the development of broadband And significant progress In the present Technologies such as ADSL2+, that Has the ability to play high-quality multimedia content, IPTV market has great potential for growth, Nature of IPTV mechanism in the Quality of Service is limited particularly zapping time, That is defined as the time difference between user demand via the remote control for changing channels and display the first frame of the requested channel on the TV screen, the zapping time of channels is an important issue in Quality of experience performance in IPTV. Channel change delay in IPTV networks is the same zapping time may take up to 2 seconds or more, The main reasons for this delay are the internal processing delay, Decode delay and buffer delay, IPTV uses the compression technology to send video And encodes the raw stream To save bandwidth, Therefore it is need to decode video in user equipment, To decode, the buffering is needed That these technologies will cause a delay in IPTV networks And viewers will have to wait to see the images on TV, whereas for customer satisfaction and provide QOE this number should be under 430 ms [1], The channel switch time is recognized as an one of the metrics of the IPTV QOE, One way to reduce the channel switching time is predictive adjustment, In this study time to switch is reduced by pre-joining Predictive channels, If the user switches the channel, STB sends an IGMP protocol And sends messages to join a new channel and leave the old channel, One of the ways to reduce the time channel zapping is to join the neighbouring channels to the current channel, If the user switches a neighbouring channel will be able to watch the selected adjacent channel no time zapping Because the neighbouring channels stream has already been sent to the STB, This method is called predictive set, With predictive adjustment, additional bandwidth are needed. At pre-joining channels, a way to reduce bandwidth is surfing. This means that when a user is watching a channel STB takes only the current channel And when the user switches a new channel, STB receive more channels in addition to the current channel, ever time the user decides to watch the channel, STB will leave extra channels that is called surfing. With this method, the Average of bandwidth consumption will be reduced. Anyway, switching channels tolerate more bandwidth that with The accurate prediction we can reduce This consumption for the next channels, one of Guidelines for the selection of channels is The popularity of the channel and other words the user's personal preferences to select channel, In order to achieve optimal time of zapping Two approaches are required in pre-joining channels as follows: Determination of most pre-joining channels based on user´s Channel selection behaviour and Selection of the pre-joining channels with a button priority interference for user Choices on the remote control unit. A pre-joining method has two useful characteristics as follows: pre-joining can be implemented toward user Purely Without changing network and Channel zapping time is reduced almost to zero by pre-joining channels. This one will happen by decoding data stream or buffering Key frames which is called the I-frame. In this article, the second part is an overview of the structure of the IPTV network also Factors causing delay in channel switching and method of reducing this delay will be checked. The third section will discuss about the computational model to describe the behaviour of a user channel selection and channels pre-joining method to reduce channel switching delay The fourth section is given the numerical results of simulations to evaluate the performance of pre-joining channels And the pre-joining channel selection which is made based on the channel switching time and bandwidth usage, The fifth section contains the presented conclusion and recommendations in this field.

II. IPTV NETWORK

A typical IPTV system consists of four elements as figure 1 [2], Content Provider Performs encryption of video content received via satellite or fibre network which this format for compressing can be MPEG2 or MPEG4, Compressed content is encapsulated into IP packets and Be sent with multicast IP or unicast IP towards the network core and Network core categories Compressed content to related channels and it consider an IP For each channel, access network includes the BRAS and DSLAM,. BRAS is responsible for managing user access where Can be identified a user's identity and user permissions will be examined, DSLAM provides Technology of access to IPTV for final user that the used technology for the user in This study is ADSL2 +, in Home network section, Required equipment includes a modem and STB which have The ability to decrypt, synchronization and buffering A television set is required for watching video and Be able to connect to STB, Delay in the delivery of content to the user in each of the four elements provides necessity to establish methods to reduce this delay To be the basis for guaranteeing quality of service and user satisfaction of the service.

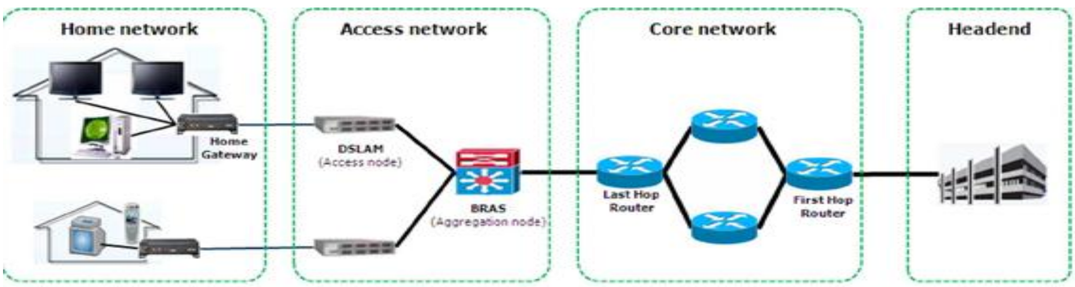

Figure 1. IPTV service system

2.1. Channel Switching Time

In traditional analogue TV broadcast and cable technology, channel switching is almost instantaneous because it only includes TV receiver adjustment to a specific carrier frequency, demodulation of content and display it on the TV screen, Channel switching delay in this system is usually less than 200 ms So TV viewers consider the channel switching times potentially immediate And have been used to accustom to this searching experience. the numerical content And it´s compression have dramatically increased the channel switching times, today´s Users Experience this in digital TV cable networks But it is even more serious problem in IPTV because of network delay, Channel switching times are also affected from this delay, Users who will change the channel on IPTV Usually experience a delay of two seconds or more. Kooij [1] recently presented a study that concluded in order to obtain acceptable quality of service, channel switching time must be below 430 ms Although this study is limited by the size of the test population It is clear that by increasing the IPTV channel switching time will reduce quality of the experience gained by consumers and is a major obstacle to the adoption of a range of IPTV services. Since bandwidth is a scarce resource on the network, Have created Media efficient coding schemes such as MPEG-2 and H.264 and MPEG-4, They use this fact that In a typical sequence of video frames, adjacent frames are highly correlated to each other Hence, the dependencies between neighbouring frames are used to enhance the coding efficiency. in this project Video streams are divided into parts which each normally a group of pictures known (GOP) (Figure 2), Video is encoded with three types I and B and P frames are defined differently, I-frame is as a single image without any reference to the previous and next frames, P-frame is a predicted frame and establish based on the past I-frames. It is not actually an encrypted image and is a movement data that allows the IPTV consumer for re-building frame, I-frames need less bandwidth than P-frames Specifically it is important to IPTV networks, B is a bidirectional frame that contains information about the I and P-frames, Encoding for B-frame is similar to p-frame which Apart from motion vectors refers to areas in future frames, B-frames occupy less space than I and P-frames But a fundamental problem in this case is the time delay, Because IPTV consumer devices need two reference frames to decode this frame, this three types of frames are combined together And a continuous sequence of frames is called the GOP, A GOP starts with an I-frame, There are a number of B-frames and P Throughout the video stream, Although the size of the GOP change, The average size of GOP is between 12 to 15 frame, in an IPTV environment, encoder needs I frame To decode a video stream as the first frame of reference that can be decoded Without more information Therefore, to optimize the channel switching time it is useful to send burst frames of I, With this method, decoding and playback can be started earlier And reduce channel switching delay, The problem is that I frames are significantly larger frames of B or P-frames Which needs more storage space and higher bit rates to be transmitted that depending on the content that can be moved This difference can be a great degree , There are so exchanges between effective compression on the one hand and on the other switching channel performance , Practically GOP period is a range of 0.5 to 2 seconds [3,4], However, more advanced codec will need to more GOP for effective decoding, After the STB receives the first packet of a multicast group, Before STB can start using data, voice and video, There is a the time delay , because STB should obtain the specific reference information, In particular, STB should wait for the next I-frame before it can start decrypt the content, This is referred to synchronization delay, max sync delay is equal to GOP period, That occurs when the STB misses the start of the I-frame, And must wait for the next frame, approximately delay is half of the duration GOP, So make up a significant proportion of the channel switching time

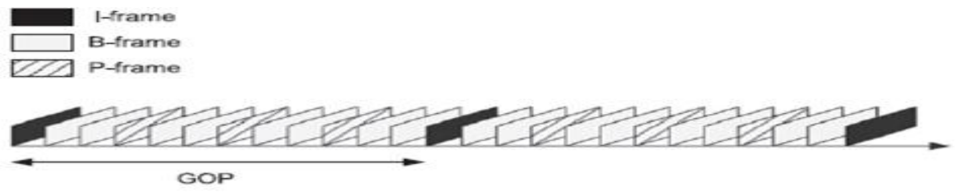

Figure 2. Typical frame structure

2.2. H.264/SVC Video Coding Techniques

ways to reduce the bandwidth consumption in video encodings techniques of reduction of delay in channel switching has been existed, One of these methods is video encoding H.264/SVC, this method is expanded H.264/AVC, Bit stream of SVC are included in a base layer and one or more the additional layer, H.264/AVC is a bit stream of base layer, That ensures backwards compatibility for the decoders, and will cause low quality of picture and low resolution (temporal resolution) or low resolution image (PSNR), Incremental layers contain data from frames with higher resolution and frame rate , But it will not be decoded without a bottom layer, Inexpensive devices having low resolution, low computational power or low network capacity, Can only take the lower layer, and expensive equipment can take the Base Layers and also layers of incremental, Lee and colleagues showed that good quality of images are obtained from the basic layer to change the channel, which uses Bandwidth about 10 times less than the overall SVC stream [5].

2.3. A brief look at history predictive pre-joining of TV channels

As far as we know the first paper that suggests pre-joining channels, Scheme where every STB is connected to more multicast groups simultaneously with requested channel by the user Were presented by CHO and colleagues [6], in their proposal More channels are Neighbouring channels with the channel being watched, The main problem was that the plan did not provide any evaluation , paper offers a pure description of idea , In addition without any changes in the plan they are very inefficient, Adjacent channels are sent with requested channel continuously, So when the user is watching the channel (the channel does not change) all channels are present in the STB, So they consume the extra bandwidth, Two other papers [7,8] have proposed a similar plan, but they solve Two problems of the original article, first, they deliver adjacent channels for a limited and specified period, Their designs are so efficient in terms of bandwidth, they also evaluate plan with an analytical model To review the performance of each of their plans, Recently, some of the assumptions they applied their simple models have been proven that were wrong that this was the main problem this two article. By analyzing real data , Recent studies [9,10] proved that the behaviour of channels change is not be model with simple applied models of the experts [7,8], Recently, more sophisticated schemes are analyzed, Oh and colleagues [11] presented a hybrid plan, that the proposed pre-joining and sorting, experts consider two plan for pre-joining, The first one is pre-joined the adjacent, And another one is pre-joined most popular channels, They combined both of them with a reordering channels plan, In this, popular channels are grouped together in a sequence of linear search.

III. CHANNEL SWITCHING BEHAVIOUR

in Channel selection it can be seen two types of response and behaviour in user as follow: What channel number will be changed by user And before their entry into view period, What time do they spend to switch channels and While they are switching channels, what channels they choose, The first question will be called the channel switching behaviour And the second one called the channel search reaction [2]. Fortunately, a measure for the behaviour of real IPTV services are available, To examine how user channel selection in the real world signs of commercial IPTV large-scale are used. This study shows [12] that generally user change 4 channels before using the channel, While 10% of users have changed channels more than 6 times before watching, Figure 3 increasing distribution function (CDF) of the channel numbers of changes before watching show that CDF is described by the Poisson distribution, As was said the number of switches before watching can be followed Poisson distribution, To analyze this behaviour was used from semi-Marko process, It works similar to the following steps any status shows number of the switches, transition to the next state shows the switching, And the transition to state ‘0‘ shows view instant, When the user is viewing channel user is in state ‘0’, When is in channel switching state, Is transferred to state ‘1’, If the user decides to watch channel the user returns to state ‘0’, Conversely, if the user changes the channel The user enters state ‘2’ (Figure 4)

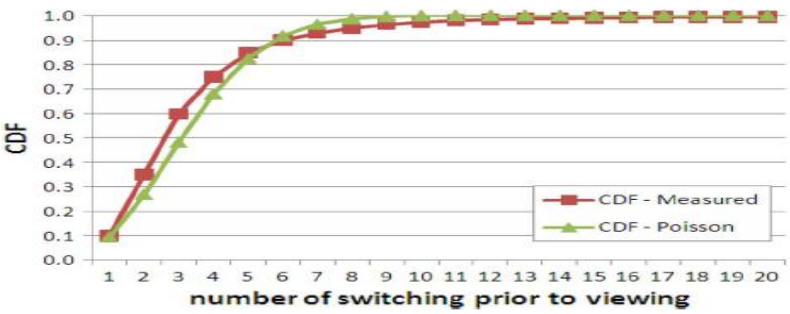

Figure 3. CDFs of the number of switches prior to viewing and Poisson distribution.

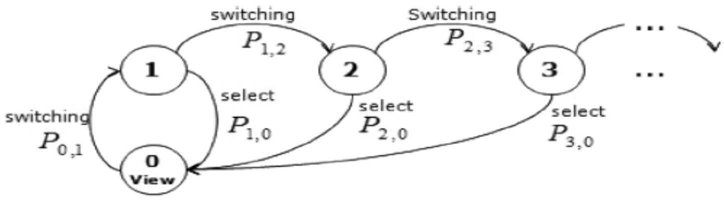

Figure 4. State transition diagram of channel switching.

According to this assumption, probability of transmission can be calculated from the Poisson distribution, If the user switches once before watching, It means that the user can move from State '0' to state '1', And then the user returns

$$p_r\{switching\ once\ prior\ to\ viewing\ \} = \frac{e^{-\lambda}}{1!} = p_{0,1} \cdot p_{1,0}$$

$$p_r\{\ switching\ k\ times\ prior\ to\ viewing\ \} = \prod_{i=1}^{k} p_{i-1,i} \cdot p_{k,0} = \frac{e^{-\lambda}\lambda^{k}}{k!}\ ,\quad (k \geq 2)$$

Probability of outgoing of each state must be 1 hence,

$$p_{0,1} = 1\ ,\qquad p_{i,0} = 1 - \ p_{i\ ,i+1}$$

From Combining the above equations can be reached to following formula

$$p_{k-1,k} = 1 - \frac{e^{-\lambda}\lambda^{k}}{k!} / \prod_{i=1}^{k} p_{i-1,i}\ , (k \geq 2) \qquad (1)$$

We consider that the numbers of states to switch between different channels are limited, this is acceptable in terms of human behaviour, and Number of switches between channels is limited to 100 (Figure 4)

3.1. Channel Search Behaviour

Users often use remote control that have many buttons such as up and down, preset, on or off, numerical, There are two preferences as follows: button preference, channel preference. Button preference refers to buttons Often a user uses on the remote control unit and channel preference refers to How often the user will watch one channel.

3.11. Determining number of pre-joined channels

there are two aspects During the period of observation for pre-joining, pre-joining in the observation period more than pre-joining in the search period impacts on average time of channel change, Because The first switch of any search would be affected by that, pre-joining in the observation period will consume significant bandwidth, because the observation period is longer than the search period, So we need finding Optimum number of pre-joining channels in the watch in during and the period of the search, from proposed Semi-Markov models (SMP) can be calculated expected time of channels change and the expected bandwidth consumption, the number of pre-joining channels in the period of search and period of watch as a variable are considered, By setting these variables expected bandwidth consumption changes and the expected time of channel change can be calculated.

3.1.2. Pre-joining channel selection

remote control has a variety of buttons including up/down, dual-mode, preset and numeric buttons Thus, a user can use different ways to switch to the desired channel, For example, if the user watch Channel '9' and user decides to change to channel '12' his favourite channel, Can press the up button three times or by pressing the number '12' to reach the desired channel (Figure 5)

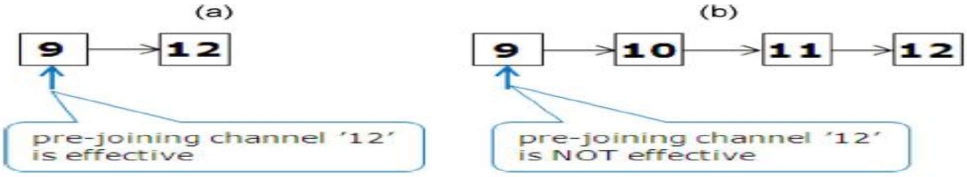

Figure 5: Two cases of channel surfing from channel '9' to channel '12': (a) 'numeric' button; (b) 'up' button.

in predictive adjustment the most important channel is not a favourite channel, except the next channel ,because STB again selects pre-join channels every time a user switch to a channel, it means the button preference more than the channel preference affect, If there are N channels and K types of buttons, η_k shows button preference of buttons k (1, ... k), And are considered channel preference of channels j (1 ... N), and defines the numeric button preference, So we can define the combined probability of channels and button preference and each channel j at any particular moment as follows

$$w_j = \eta_1 \rho_j + \sum_{k=2}^{K} \eta_k \beta_k^j, 1 \le j \le N$$

$w_j w_j$

$$\beta_k^j = \begin{cases} 1 & \text{channel j corresponds to button k} \\ 0 & otherwise \end{cases} \quad (2)$$

Except for the numeric buttons, channel corresponding to a button depending on the current or previous channel or user status, Thus STB can obtain the correct value in each switching, However do not use to calculate the expected time to channel change in the proposed SMP model, because is for a particular moment and is not for usual status, Instead of we use an approximation value in permanent state for proposed SMP model, We assume that there are more K-1 channels related to the buttons, except the numeric buttons, Approximate probability of channel j is obtained as follows:

$$\Pi_j = \begin{cases} \eta_1 \rho_j & 1 \le j \le N \\ \eta_{j-N+1} & N+1 \le j \le N+k-1 \end{cases} \quad (3)$$

3.2. Expected Channel Switching Time

Expected time to channel change depends only on the number of transitions between states, and does not depend on the spent time in the state, so excepted time for switching channels can be obtained from permanent state of discrete time Markov chain (DTMC) and the transition probability. about The nature of predictive setting if the user goes to a channel that is not pre-joining, In fact, he will use time to channel change for Finishing IGMP messages exchange processes, waiting for stream and decoding forcibly, We call this issue full delay and show it to Mark F, if user switch to channel that is not pre-joined In fact it does not spend any time to channel change, if we define C_i as a collection of pre-joining channels in i-state, expected Delay in case i can be represented as

$$E[D_i] = \sum_{j \varepsilon C_i} \Pi_j \cdot 0 + \left(1 - \sum_{j \varepsilon C_i} \Pi_j\right).F \quad (4)$$

In Calculating the expected time to channel change we should consider when the channel change occurs, the transfer switch from i to i +1 occurs, that makes channel change time, So the proportion E[D_i] in the excepted time to change the channel can be obtained from the possibility of steady-state transition from i to i +1, That can be presented as follows:

$$\pi_{i+1} = \pi_i \, p_{i,i+1}$$

If it is assumed that the number of state is limited to m+1, Placed DTMC steady state probability can be obtained from this equation:

$$\pi_0 = \pi_1 p_{1,0} + \pi_2 p_{2,0} + \pi_3 p_{3,0} + \cdots + \pi_m p_{m,0}$$

$$\pi_1 = \pi_0 p_{0,1}\ , \pi_2 = \pi_1 p_{1,2},\ \ \dots\dots\dots\ \ , \pi_m = \pi_{m-1}\, p_{m-1,m}$$

$$\sum_{i=0}^{m} \pi_i = 1$$

that gives:

$$\pi_0 = \frac{1}{p_{0,1} + \sum_{i=0}^{m-1} \prod_{j=0}^{i} p_{j,j+1}}, \pi_i = \pi_{i-1}\, p_{i-1,i} \qquad (5)$$

The probability that a transition from i to i +1 occur in steady state:

$$\pi_{i+1} = \pi_i\, p_{i,i+1}$$

So expected time of changing channels can be achieved as follows: $E[D]$

$$E[D] = \sum_{i=0}^{m-1} \pi_{i+1}\, E[D_i] \qquad (6)$$

3.3. Expected Bandwidth Consumption

Using SVC, IPTV is divided into a base layer and an enhancement layer that are Assigned to different multicast groups [9],in watching moment STB receives each two layer of current channel and base layers of pre-joining channels**.** As shown in Figure 6, If we define n_i as the number of pre-joined channels in state i, Bandwidth consumption in each state will be obtained as follows:

$$BW_i \begin{cases} (n_i + 1)BW_{base} + BW_{enh} & i = 0 \\ (n_i + 1)BW_{base} & i \neq 0 \end{cases} \qquad (7)$$

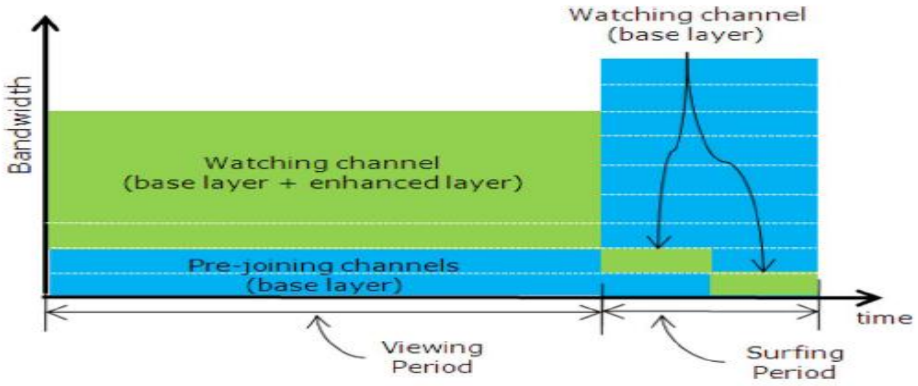

Figure 6: Bandwidth usage in the proposed method.

We define as the amount of spent time in state i, SMP steady-state probability will be obtained from the probability of given constant state DTMC and spent time in states:

$$\rho_j = \frac{\pi_j \mu_j}{\sum_{i=0}^{m} \pi_i\, \mu_i}$$

Expected bandwidth consumption is calculated from the following equation**:**

$$E[BW] = \sum_{i=0}^{m} P_i BW_i \qquad (8)$$

IV. SIMULATION AND ANALYSIS OF IT

To make the more explicit comparison, number of pre-joining channels policies, , are compared with the selection of same pre-joining channels, Selection methods of pre-joining channels are compared with the same policy for the number of pre-joining channels, Default parameters for the analysis and simulation, Full Delay (F) (the amount of time it takes the requested channel by the user reaches STB) which is 2 seconds [2] and the total number of channels is 50 (N), Base layer bandwidth 1 Mbps and enhancement layers bandwidth are 8 Mbps that For HD video quality are required [2], channel preference with a zipf-like distribution with S = 1.2 is considered, And the number of switches before watching is considered with the Poisson distribution λ = 3.7, The amount of spent time in a Watching period is 12-minute, While the amount of time spent at an period of Search $(\mu_i, i \neq 0)$ 9 seconds is considered, A remote control has three button numerical, up or down, and preset, And these three types, follow user button preference, For comparison in same condition all methods use from H.264/SVC, where pre-joining channel, only uses the bottom layer, also Comparison of peak bandwidth consumption of each method is done also bandwidth consumption Peak affects on network congestion significantly because caused switch by Business interruptions For example about 95 percent total switches a viewer are considered, This means that at a particular moment, channel switches can reach to peak, And use of broadband in period of search may be critical to network congestion

4.1. Number of Pre-joining Channels Politics

Three policies are evaluated for number of pre-joining channels that are compared with the channel change time average and bandwidth consumption average as is shown in TableI. As mentioned earlier, each policy selects pre-joined channels according to the channel preference for comparison under the same conditions

Table I. Policy Number of pre-joining channels

Policy	Description
Always	A number of channels are always pre-joined
SURFING	A number of channels just in search time are pre-joined
proposed (v=5)	A different number of channels in surfing Period and the Channel 5 in watch period are pre-joined

As previously mentioned expected Channel change time must be below 430 ms To meet QOE, by performed simulation for this aim reached to this conclusion that (Figure 7) always, a solution method with 13 pre-joining channels And the proposed method provides 15 pre-joining Channel in the search time and 5-pre-joining channel in the watch period, but pure surfing method will not be solving, It also shows that increasing the number of pre-joining channels becomes ineffective gradually**,** Figure (8), the expected bandwidth consumption of each policy with a number of different pre-joining channels shows, always method with pre-joining channel 13 uses 21.4 Mbps, While the proposed method with 15 channels in surfing period and 5 channels in watch period are consuming 14 Mbps that Provides a bandwidth improvement of 31.3%, It also shows that the more number of pre-joining channels in Search period rarely affects the average of bandwidth consumption, Figure (9) shows the bandwidth consumption peak of each method, the always method with 13 pre-joining channels consumes 22 Mbps, While the proposed method (v = 5) requires 16 Mbps That has a 27 percent improvement in the Table II are presented Numerical results for the channel change time average about 430 ms for the three pre-joining channels policy.

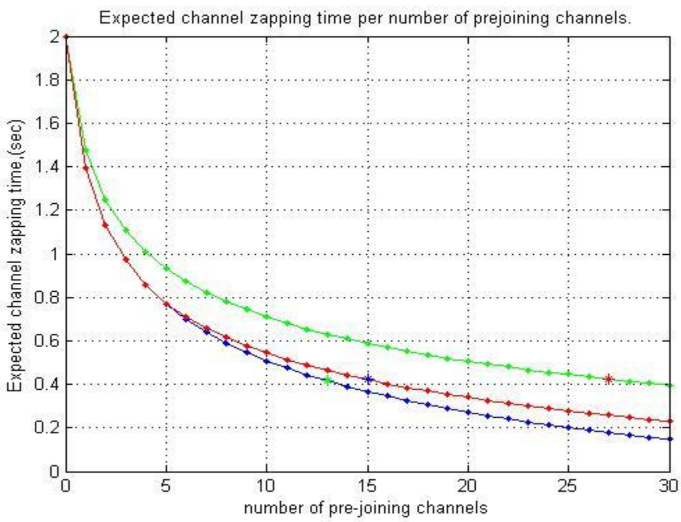

Figure 7. The excepted time average of channel change in the number of prejoining channels for Number of pre-joining channels policies in the average time limitation of channel change 430ms, blue diagram is always policy, green diagram is surfing policy, red diagram proposed policy

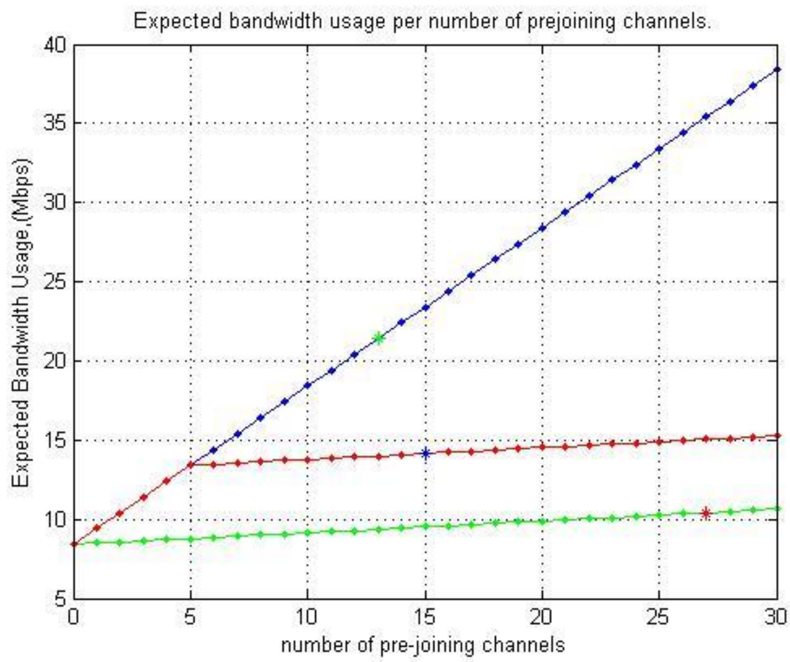

Figure 8. The excepted bandwidth of consumption average in the number of prejoining channels for Number of pre-joining channels policies in the average time limitation of channel change 430ms, blue diagram is always policy, green diagram is surfing policy, red diagram proposed policy

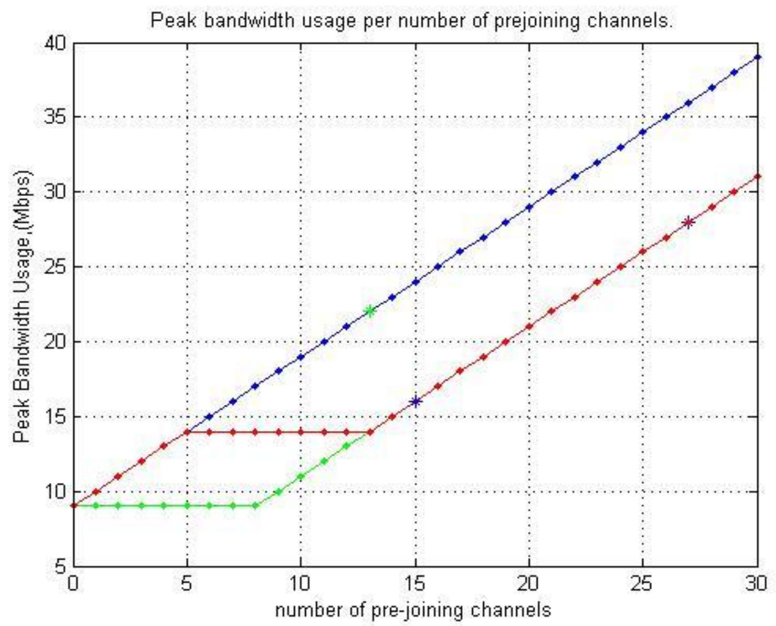

Figure 9. The bandwidth consumption peak in the number of pre-joining channels for Number of pre-joining channels policies in the average time limitation of channel change 430ms, blue diagram is always policy, green diagram is surfing policy, red diagram proposed policy

Table II. Numerical results for the channel change time average about 430 ms for the three pre-joining channels policy

Policy	**Number of pre-joining channels**	**Time average of channel change (s)**	**bandwidth consumption average (Mbps)**	**bandwidth consumption peak (Mbps)**
always	13	0.4163	21.407	22
surfing	27	0.4245	10.4068	28
proposed (v=5)	15	0.4217	14.1481	16

To make a pure surfing Method, bandwidth consumption peak is important Note that the used transmission method is ADSL2+, Max downstream speed for that is 24 Mbps, For three policy (proposed and always and surfing) Table III obtained from simulation

Table III. Numerical results for the bandwidth consumption peak about 24 Mbps for the three pre-joining channels policies

Policy	**Number of pre-joining channels**	**Time average of channel change (s)**	**bandwidth consumption average (Mbps)**	**bandwidth consumption peak (Mbps)**
always	15	0.3674	23.4077	24
surfing	23	0.4675	10.1106	24
proposed (v=5)	23	0.3011	14.7404	24

Due to the limitation of bandwidth consumption peak Can say that the proposed method is better than other methods, Because in the always method although the number of pre-connection channels in search period is half of the two other methods But the average consumption of bandwidth is close to the maximum bandwidth And may this large amounts of bandwidth lead to critical issues in transmission, in surfing method also since the average time of channel change in the height of the bandwidth consumption peak is greater than 430 ms, Can not be arbitrary method, while the proposed method can have Desired channel change time to provide QOS in the bandwidth consumption peak. In the proposed method have been changed the number of channels in watch period, and the following results were obtained according to numbers in the table can conclude, Increasing the number of channels in watching period.

Table IV. Numerical results of the proposed method of pre-joining channel with variable prejoining channels in watching period for the bandwidth consumption peak about 24 Mbps

Policy	**Number of pre-joining channels**	Time average of channel change (s)	bandwidth consumption average (Mbps)	bandwidth consumption peak (Mbps)
always	15	0.3674	23.4077	24
SURFING	23	0.4675	10.1106	24
proposed (v=1)	23	0.3858	**11.0366**	24
proposed (v=2)	23	0.3503	**11.9625**	24
proposed (v=3)	23	.3284	**12.8885**	24
proposed (v=4)	23	0.3129	**13.8144**	24
proposed (v=5)	23	0.3011	**14.7404**	24
proposed (v=6	23	0.2916	**15.6664**	24
proposed (v=7)	23	0.2837	**16.5923**	24
proposed (v=8)	23	0.2769	**17.5183**	24
proposed (v=9)	23	0.2711	**18.4442**	24
proposed (v=14)	23	0.2500	**23.0740**	24
proposed (v=15)	15	0.3674	**23.4077**	24

Will cause a increase in consumption bandwidth usage, and reduce the time average to change the channel And in a range the proposed method will be same with the always method, for The above table it will occur for v=15, Where all values are the same with the always method, So we can say that in the proposed method number of pre-joining channels in watching period should be less than the number of pre-joining channels in the always method having the bandwidth consumption peak 24 Mbps

4.2. The New Proposed Method for Pre-joining Channels

in performed plan to reduce the channel switching delay From an operational IPTV [13] provider including of 255 thousand users 150 TV channels And cover a period of six months It was concluded that the majority of channel switching events are relatively predictable For example users linearity will switch to the next channel with Up or down the channel This fact led that Using this database A special type of solutions For the problem of channel switching delay was analyzed That is as predictive joining, So most users for the next channel will switch to bottom or top channel Even when channel change is not linear Jump distance is usually small meaning There is a high possibility for the user to switch to one of the adjacent channels This fact can be seen in Figure 10 In this figure Probability of channel switching linearity (one-hop distance) Nearly 55 percent And probability of jump to adjacent channel also is very much for example Eighty percent of all requests for channel switching would be For channels which are not too far away Six (jump distance 6 or less than 6)

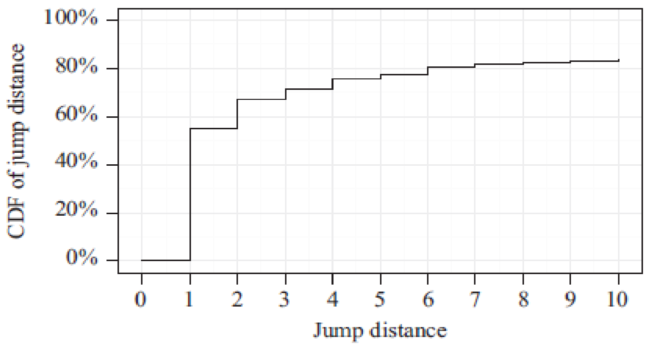

Figure 10. Cumulative distribution of zapping jump distance

base on the observation Of these massive data sets can propose New solutions to reduce the channel switching which in this way in selection the pre-joining channels based on channel and button Preference [2] Once the user uses up and down buttons to change the channel Instead of pre-joining one channel before or after the requested channel, Several channels before or after the requested channel also will pre-join that In this study, Number maximum of pre-joining neighbouring channels is up to 5, in simulation of new proposed method is used from Figure 10 for the up or down button preference, This means that the jump probability with one distance (A channel before or after requested channel) 0.55, the jump probability with a distance of two (two channels before or after the requested channel) 0.13, the jump probability with three distance 0.06, the jump probability with four distance 0.05 and the jump probability with five distance 0.03 will be interference in button preference. To compare, Two users are considered, in order to determining pre-joined channels is used for the first user from the channel and button preference proposed model [2] And for the second user from the channel and button preference new proposed model The description of these two user is given The table V, for channel preference from distribution of the zipf-like and for button preference from The jump graph(Figure 10) and blow description is used ,Both user use 45 percent from the numeric buttons 45 percent from up or down buttons And 10 percent from the preset buttons in order to the channel change, Number of adjacent channels in The new proposed method was Changed up to 5 channels And the obtained numerical results Of this change compare and evaluate to the first user

Table V. selection policy of pre-joining channel between two user The first with proposed model and The second with proposed new model Numerical results to time Average of channel change About ms 430 And bandwidth peak 24 Mbps is given in tableVI:

user	Description
The channel and button preference for proposed method **[3]**	When the user to change the channel use from up or down buttons one channel before or after the requested channel with the demand channel are pre-joined

The channel and button preference for new proposed method	When the user to change the channel use from up or down buttons Up to 5 channels before or after the requested channel with the demand channel are pre-joined

Table VI. Numerical results to policy of pre-joining channels selection between two user The first with proposed model and The second with proposed new model.

user	Policy	Number of prejoining channels	Time average of channel change (s)	bandwidth consumption average (Mbps)	bandwidth consumption peak (Mbps)
The channel and button preference for proposed method (v=5)	One adjacent channel	7	0.4206	13.5558	14
		23	0.1692	14.7404	24
The channel and button preference for new proposed method (v=5)	two adjacent channels	6	0.3873	13.4817	14
		23	0.1328	14.7404	24
	three adjacent channels	6	0.4291	13.4817	14
		23	0.1404	14.7404	24
	four adjacent channels	7	0.4204	13.5558	14
		23	0.1527	14.7404	24
	five adjacent channels	7	0.4204	13.5558	14
		23	0.1606	14.7404	24

According to the simulation results which in TableVI has been noted It can be said In case the user uses up or Down buttons to change the channel And two channels Before or after the requested channel is pre-joined for user In this case the pre-joining number of channels and the average time of channel change and average bandwidth consumption will be Less than other states in TableVI that Even is better from the states that the number of adjacent channels from 3 to 5 digits will change This will make the proposed method more efficient. according to results in TableVI Even in states that 3 to 5 adjacent channels are pre-joined although the number of pre-joining channels to proposed method is the same But the a negligible improvement is observed in channel change time average and bandwidth consumption average. in simulation pre-joining of the new proposed method with Two adjacent channels, Number of pre-joining channels were Equal to 6 channels at the time of search And 5 channel in viewing time, this simulation also performed for proposed model with the same Number of pre-joining channels (6 channels at the time of search And 5 channel in viewing time) in the same conditions with, Percent of improvement in output of simulation is observed that in The table VII Numerical results from Simulation is visible.

TableVII. Numerical results to policy of pre-joining channels selection between two user The first with proposed model and The second with proposed new model with two adjacent channel

user	Policy	Number of pre-joining channels	Time average of channel change (s)	bandwidth consumption average (Mbps)	bandwidth consumption peak (Mbps)
The channel and button preference for proposed method (v=5) [2]	One adjacent channel	6	0.4606	13.4817	14
		23	0.1867	14.7404	24
The channel and button preference for new proposed method (v=5)	Two adjacent channel	6	0.3873	13.4817	14
		23	0.1328	14.7404	24

V. CONCLUSIONS

As mentioned already selection behaviour of user channel is analyzed with Semi-Markov Process and not only The time average of channel change and bandwidth average was estimated but also the optimum number of pre-joining channels In a searching period and a watching period was get by it. The simulations were performed for approve of it. The proposed method is used for pre-joining channels, in this method, Number of channels are pre-joined At the watch time And some At the time of switching between the channels (surfing) which this method With the accomplished simulations Showed that having The better time average to channel change and the better bandwidth consumption average than always and surfing methods, Also, two users were considered in order to select pre-joining channels That in the same conditions were simulated, in the first simulation we had two users that pre-joining channel selection For the first performed Only based on the channel preference And for the second user based on the button and channel preference, also in simulation the two users was considered Which pre-joining channels selection For the first From proposed method And for the second user From new proposed method was used The simulation results showed Which new proposed method reaches to more efficient Average time to channels change than The proposed method [2], In each simulation the results of channel change time Average And the bandwidth consumption average Was comparable base on the number of pre-connecting channels with change the channel time below 430 ms And bandwidth consumption peak 24 Mbps. In this research study is limited only to the user equipment it is required to study on network equipment to achieve better results.

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