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Reducing Mobile IPTV Traffic in 3G Network by Providing Favorite Channels in DVB-H Network

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Abstract: Mobile IPTV is one of the IPTV branches which is growing rapidly in the entertainment world. This popularity is the result of high penetration of mobile phones which are one of basic tools of nowadays' life. DVB-H network is one of the major infrastructures for mobile IPTV where its battery efficiency methods, lower usage fees and high bandwidth availability make it a powerful and popular network for supporting mobile IPTV. This study presents a novel concept for mixing 3G and DVB-H network to develop mobile IPTV. In this study, we propose a mixed framework of combined DVB-H and 3G cells in order to push public favorite channels traffic to DVB-H network in order to reduce 3G network traffic and users usage fees. Based on our previous researches by considering some public favorite TV channels as additional channels in DVB-H network, we try to present a new method to shift mobile IPTV traffic to DVB-H network. By combining 3G and DVB-H, users leaving a 3G area and entering a DVB-H area can continue watching their videos by vertical handover between 3G and DVB-H networks. In addition, by broadcasting some additional TV channels in the DVB-H network to reduce users' usage fee, we extend the coverage area and reduce the traffic of 3G network. Our performance evaluation results show the effectiveness of the proposed combination on improving the quality of service for mobile IPTV users.

Key words: DVB-H, 3G, mobile IPTV, vertical handover, favorite channels

INTRODUCTION

Nowadays, mobile phones and their features are growing and they have been turned into very fast and powerful handy computers. Users can carry out almost all of their office works with them. In addition, users can connect to internet through their mobile phones, watch TV, download and upload videos, search the web and so on.

Basic definitions: IPTV is a service that provides multimedia services such as video and audio through internet connections for users. Mobile IPTV provides IPTV service for users who want to use it in their mobile devices. One of the main methods to provide mobile IPTV is DVB-CBMS (Digital Video Broadcasting-Convergence of Broadcasting and Mobile Services) that develops a two-way communication between a user and an IPTV server to interact (Ibanez *et al*., 2008; Gomez-Barquero *et al*., 2007; Hartung *et al*., 2007).

The DVB-H is one of the branches of European Standard of Digital Video Broadcasting customized for handheld devices. This standard is used to provide multimedia services for mobile devices. The main features of DVB-H are: Digital Video Broadcasting Handheld time slicing that allows mobile devices to save their battery and MPE-FEC that improves strength of transmitted signals. The DVB-H has a key feature called Electronic Service Guide (ESG). The information of channels transmitted by DVB-H is included in ESG (Hartung *et al*., 2007; Park and Jeong, 2009; Minoli, 2008; Pentlinen *et al*., 2009; Mikoczy *et al*., 2011; Huttl and Kratochvil, 2011). By downloading an ESG, users can access the information of the programs transmitted by DVB-H networks.

Vertical handover: Vertical handover is a term used to explain the handover action between two different wireless networks such as 3G and WIFI, e.g. (Kondrad *et al*., 2008; Vulic *et al*., 2011; Djama and Ahmed, 2007; Kim *et al*., 2006; Tamea *et al*., 2009; Miloucheva *et al*., 2007; Stevens-Navarro *et al*., 2008; Negru *et al*., 2006; Marquez-Barja *et al*., 2011; Zekri *et al*., 2012). There are some previous researches (Kim *et al*., 2006; Tamea *et al*., 2009; Miloucheva *et al*., 2007) about vertical handover between DVB-H and other wireless networks that make decision on how to perform vertical handover. For example, by Kim *et al*. (2006) a primary structure of combined DVB-H and UTMS has been presented where a seamless handover is carried out between DVB-H and UTMS based on buffer controlling of UTMS networks. In (Kim *et al*., 2006) buffering some parts of video in UTMS buffers reduces battery usage during receiving the video via the UTMS network. A new method has been introduced by Tamea *et al*. (2009) to

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minimize the number of vertical handovers between DVB-H and UTMS/MBMS by analyzing battery usage and packet loss rate of receiving devices. Some methods for avoiding video freezing phenomena during vertical handover have been presented between DVB-H and Wi-Fi networks in (Miloucheva *et al*., 2007).

Discussion about DVB-H and 3G for using mobile IPTV: Nowadays, users can use mobile IPTV through mobile networks such as 3G, 4G and other wireless networks. These networks have some special benefits as availability in mobile situations. There are some problems in these networks such as high usage fees, limitations of network traffic and so on. On the other hand, using mobile IPTV on DVB-H has some benefits such as:

- The DVB-H does not contain any additional usage fees compared with the common wireless internet connections such as 3G and GPRS (Penttinen *et al*., 2009). This is because in many cases, the fee is for channel usage and there is no additional fee for using the DVB-H network. In some cases, the DVB-H usage could be completely free
- The coverage area of DVB-H cells is usually wider than 3G cells (Penttinen *et al*., 2009)
- The DVB-H technology has a suitable method to save battery up to 90% (Mikoczy *et al*., 2011)
- The quality of videos in DVB-H are almost better than other Internet connected videos (Penttinen *et al*., 2009; Park and Jeong, 2009)

Improving satisfaction from mobile IPTV: One way to improve users' quality of experience and satisfaction is to combine both mobile networks and broadcast networks and broadcast users favorite channels in a way that users can use IPTV services through both of them. In this study, we propose 3G network as a mobile data network and DVB-H as a broadcast network. Clearly, by combining 3G and DVB-H and broadcasting some favorite channels by DVB-H network, users can continue watching their channels by DVB-H network even if they leave 3G covered area and enter to DVB-H covered one. This action will be used to satisfy more than the current system with restricted coverage. In addition, the service providers can support more users; thus, this method could be used for marketing purposes to extend the IPTV market.

COMBINATION OF 3G AND DVB-H CELLS

This study is going present a new scheme for IPTV network that shares its contents between 3G and DVB-H networks in a way that each channel of IPTV can be shared between 3G and DVB-H network. In this way, DVB-H network can broadcast some additional channels which are popular for most of users. Figure 1 shows the network model of the presented shared model.

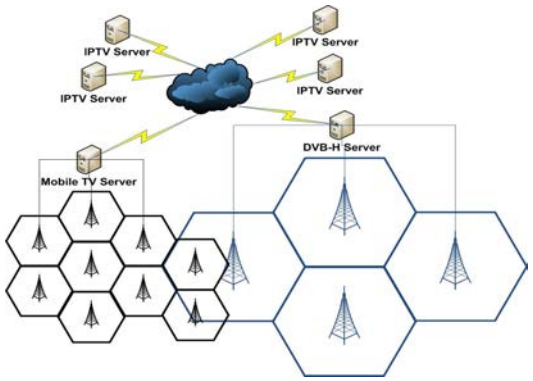

Fig. 1: Network model of mixing DVB-H and 3G networks

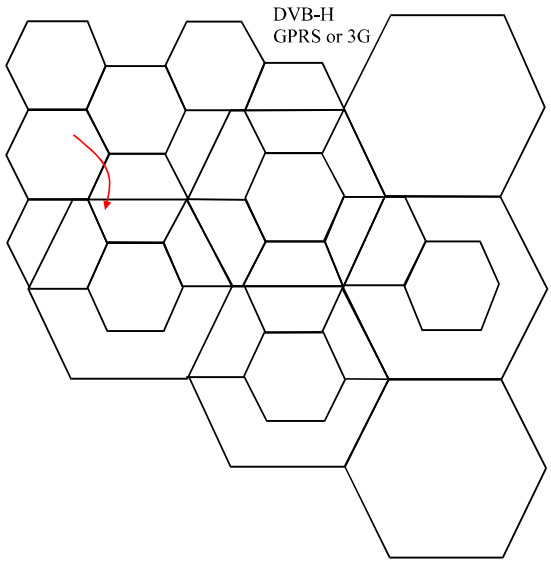

Fig. 2: A user enters the DVB-H area

Vertical handover between 3G and DVB-H: Because of users mobility, a user may exit a network or enter another network (i.e., from DVB-H to 3G or from 3G-DVB-H). Therefore, keeping the current session between the user and the IPTV server is important. In addition, we are trying to push some of mobile IPTV traffic from 3G network to DVB-H network. To reach to these goals, vertical handovers should be performed between 3G and DVB-H networks. Figure 2 shows the vertical handover action from 3G to a both 3G and DVB-H covered area (Kondrad *et al*., 2008; Vulic *et al*., 2011).

In our proposed method, the user's mobile device will notice the availability of DVB-H network and start to search the current channel in DVB-H network by

accessing the ESG (Electronic Service Guide) of DVB-H network. If the current channel is available in DVB-H network, the user will switch his network from 3G-DVB-H and start to receive the remaining video from the DVB-H network.

Favorite channels in IPTV: Intuitive experiments (Bikfalvi *et al*., 2011; Xiao *et al*., 2009; Beyragh and Rahbar, 2016) show that although there are lots of available TV channels in IPTV, only a few ones are more popular. These kinds of channels could be news, scientific, entertainment or other specific TV channels. Based on this fact, the new method presented in this study will consider some public favorite channels which are popular for most of users and broadcast them in DVB-H network. In the other hand, beside of joint channels between 3G and DVB-H networks, the IPTV server would insert the traffic of some popular channels into DVB-H network due to reduction of 3G network traffic and users usage fees. By this, our method tries to push a high volume of 3G network traffic to DVB-H which has more available band width.

We name a channel (e.g., channel 12) a public favorite channel if most of users are watching it. The popularity of the channels could be examined by social researches or analyzing users channel requests from IPTV server (Beyragh and Rahbar, 2014).

One way to recognizing the favorite channels is to calculate the visit rate of channels. If rate of channels are higher than a pre-defined threshold (for example, 30% of people request one certain channel) that channel could be named a public favorite channel (Beyragh and Rahbar, 2014).

The popularity of channels could be varied by time. For example in some events (e.g., world cup matches season), some channels may have special programs which have high chances to be requested by users. Thus, the popularity of the channels should be examined periodically to reach the best result based on users behavior in channel selection (Beyragh and Rahbar, 2014).

Adding public favorite channels to the DVB-H network: This action could be done with considering some free time slots in DVB-H network to support these additional popular channels. To reduction of DVB-H network traffic, these additional channels could be broadcast in low quality. Figure 3 shows the details of adding a new channel into DVB-H slots.

Checking DVB-H signals to recognize the availability of DVB-H network: The supported areas of DVB-H and 3G networks differ in cell sizes (i.e., DVB-H usually covers larger area than 3G). Due to shifting mobile IPTV traffic from 3G network to DVB-H network, a mobile device should be aware of existence of DVB-H signals in an area. Therefore, we should provide a mechanism for mobile devices to detect areas covered by DVB-H. The following approaches are proposed for detecting DVB-H signals.

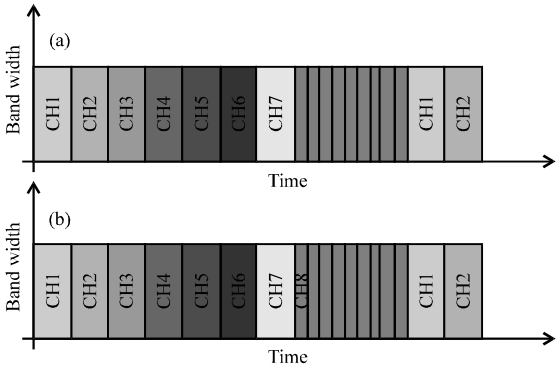

Fig. 3: Time slicing in DVB-H with sub-channels: a) each free slot could be divided into a number of sub-channels and b) new channel's traffic is transmitted via the first free sub-channel

Fig. 4: Distribution of four types of cells in the area under study in the Simulation Software

After performing handover: The areas covered by DVB-H and 3G networks may have some overlapped sections. After handover, it is easy for a mobile device to check DVB-H signals. This completely depends on the network map of both 3G and DVB-H. For example in Fig. 4a, the mobile device will notice the existence of DVB-H signals right after performing handover. However, in Fig. 4b, the device will not recognize DVB-H signals after the first handove but after the second one.

After channel switching: In this case, when a user prefers to switch the playing channel, the device can search for DVB-H signal. The chance of receiving DVB-H signals is dependent on the topology of both networks and the location of the user.

After the attenuation of 3G signals: When a device is noticed about the attenuation of 3G signals, it can scan for DVB-H signal.

Periodic scan: A device can search for DVB-H signals periodically, e.g., every 5 sec.

The combination of all above solutions: Combination of all above presented solutions may result in better results.

PERFORMANCE EVALUATION

Here, the proposed combined 3G and DVB-H infrastructure is evaluated in an area with 100 cells. The type of each cell can be one of the following types:

- Type 1: 3G cell only
- Type 2: DVB-H cell only
- Type 3 : Both 3G and DVB-H cells
- Type 4 : blind cells

We consider that 50% of the cells are of type 1, 20% of type 2, 20% of type 3 and 10% of type 4. On the other hand, 50 cells only cover 3G network, 20 cells only support DVB-H and 20 cells cover both 3G and DVB-H networks. Figure 4 depicts the distribution of network cells in the area. The simulation is performed by a custom written event based simulation.

The simulation is performed by a custom written event based simulation. Also, we considered 50 users which half of them are 3G users and the other half are DVB-H users.

In addition, we proposed 30 IPTV channels which all of them are supported in 3G network but only 10 of them are available in DVB-H network. We considered 1 favorite channel which is favorite for 30, 40 and 50% of users, respectively (favorite ratio is shown by parameter F).

The simulation results have been obtained by averaging results from 10 simulation replications with different seeds and different values of F parameter. Every simulation runs for 20 time units where in each time unit, users can either move in 8 directions or can stay at their previous places. The results based on our proposed method are shown with "Combination mode". The results obtained in the current system are denoted by "Standard mode".

Evaluation of the ratio of cut-offs in users path: As users move, they enter new areas that may not support the previous network type. For example, a user watching a TV channel via 3G enters a new area which does not cover 3G network. Hence, his connection will cut in the standard mode. Using the combination mode, the number of these cuts will be reduced. We have collected the cut off times for each user and divided them to his/her path length. The results are depicted in Fig. 5 for F = 30, 40 and 50% which means that users request the favorite channel with a chance of 30, 40 and 50%. As it is can be observed, average ratio of cutoffs under the combination mode is less than the standard mode. As the value of F parameter grows, the cut off ratio decreases which is because of increasing the fame of requesting the favorite channel by the users.

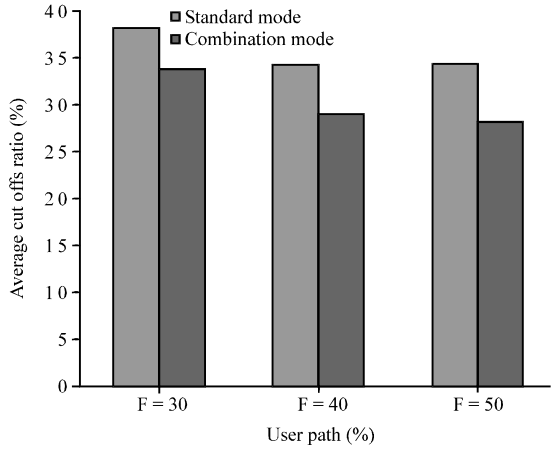

Fig. 5: The average cut off ratio in users path

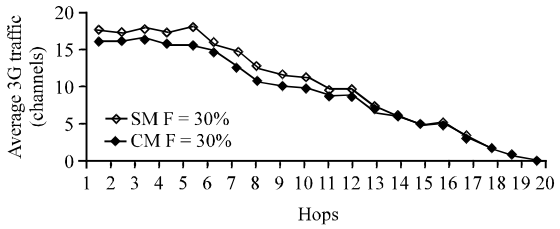

Fig. 6: Average 3G traffic based on channel

Evaluation of 3G traffic: The main goal of the Combination mode is to push some of the IPTV traffic to DVB-H network and reduce the 3G network traffic. Figure 6-8 illustrate the 3G traffic based on popularity rate of the favorite channel at F = 30, F = 40 and F = 50%, respectively.

As the shows in Fig. 5 and 6, the average traffic of 3G network in the combination mode is lower than the Standard mode. And this reduction rate increase with increasing the popularity fame of the favorite channel

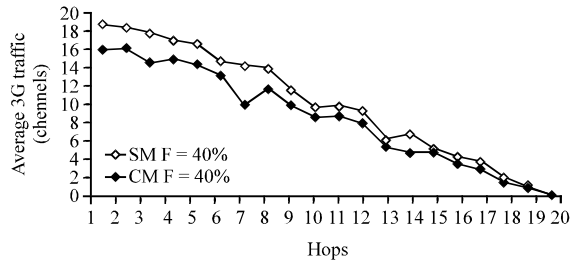

Fig. 7: Average 3G traffic based on channel

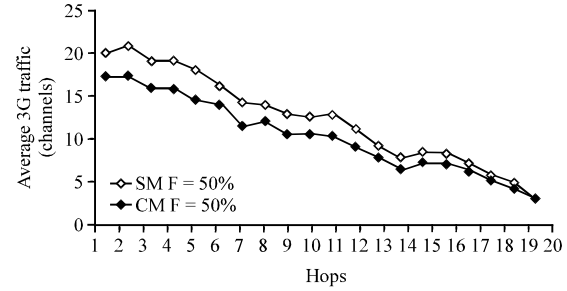

Fig. 8: Average 3G traffic based on channel

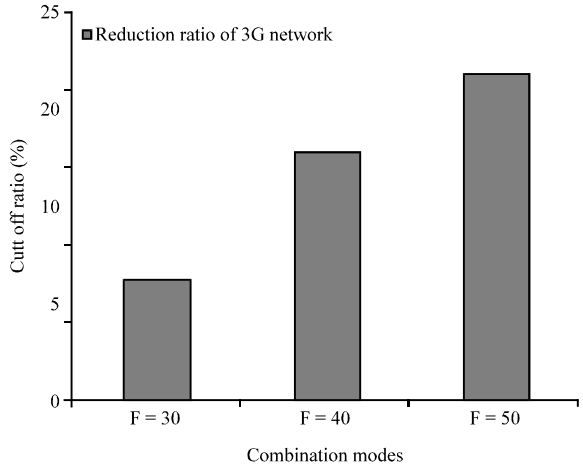

Fig. 9: Improvement of the combination mode in users cut offs

(F parameter). With finishing users paths, the usage of 3G network reduces and this is shown by the negative slope of Fig. 7 and 8.

Figure 9 shows the improvement of using the combination mode in total 3G network. As it is shown in Fig. 9, the total 3G network traffic is decreased for 8, 16 and 21% at the rate of F = 30, 40 and 50%. In the other hands, by using the combination mode, the total 3G network traffic of mobile IPTV is reduced in a good rate which by increasing the fame of the favorite channel to select by users, this improvement increases at a acceptable rate.

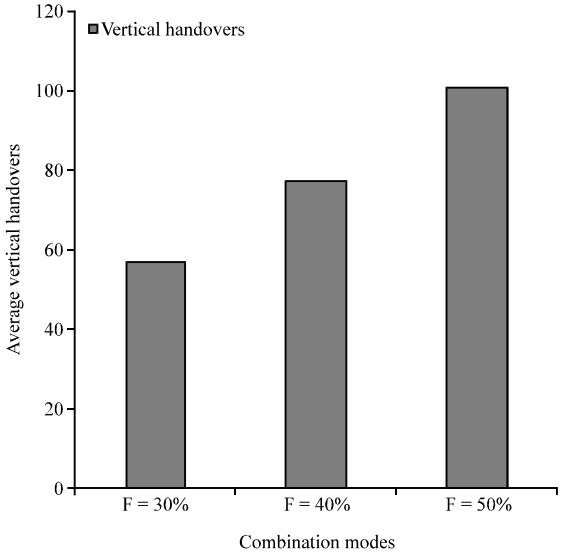

Fig. 10: Average number of vertical handovers from 3G to DVB-H network

Evaluation of vertical handover: The combination mode is based on vertical handovers between the 3G and DVB-H networks. In this study, we present the number of vertical handover operations in 3G to the DVB-H direction. Figure 10 shows the average number of vertical handovers from the 3G to DVB-H network. For example in F = 40%, almost 78 vertical handovers are performed by users in the whole 20 time hops. Which show that the combination method can reduce 3G network traffic 78 times for one channel bandwidth volume.

Figure 10 shows that growing the popularity rate of favorite channel results in growing vertical handovers, thus leading to better efficiency of mobile IPTV. Thus, users can use mobile IPTV services without interruption and with low price and low battery consumption.

CONCLUSION

To use new features of mobile devices and to improve the usage of DVB-H networks resources, a solution has been proposed to improve the quality of experience for mobile IPTV users by combination of 3G networks and DVB-H networks. By tracking users behavior in IPTV channel selection, some favorite channels could be identified and broadcast in the DVB-H network too. On the other hands, some channels which are more famous to be viewed by the users over time can be broadcast in the DVB-H network to reduce the total 3G network traffic and extending the coverage area of mobile IPTV. Our simulation results show that with considering only one favorite channel and broadcasting it in the DVB-H network, not only the total traffic of 3G network

could be reduced at a good rate but also the cut off ratio of mobile IPTV users could be reduced by an acceptable rate.

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