Customized Contents Service Over a DVB-SH/3G Network

Azza Jedidi and Frédéric Weis

INRIA,
IRISA, Campus de Beaulieu, France
{azza.jedidi,frederic.weis}@irisa.fr

Abstract. Next generation networks aim at delivering more and more sophisticated rich multimedia applications. Such applications are supposed to be personalized, interactive and available at high data rates. Recent researches generally propose the convergence and cooperation between different networks, in order to fit future application needs. In this context, we first worked on the coupling between a DVB-SH network, which is a high capacity unidirectional broadcast network and a 3G cellular network, which provides interactivity. We highlight the possibilities offered by such a cooperation through the definition of different scenarios of mobile TV services. Then, we considered the coupling between DVB-SH and MBMS networks. MBMS is an evolution of UMTS cellular network, which brings multicast and broadcast capacities, with a fine grained localization of services. In this paper we focus on enriching classical DVB TV services with customized contents delivered via 3G-MBMS path, in order to target very localized user communities[1].

Keywords: Next Generation Networks, convergence, DVB, 3G, MBMS, multimedia, personalized and localized services, mobile advertising.

1 Introduction

Recently, a growing interest has been shown in multimedia networking mainly due to the emergence of efficient audio/video encoding techniques and the proliferation of enhanced audio-visual services. The demand for these kinds of applications has quickly increased. Major advances in communication and network technologies have made multimedia services technically and economically doable in any type of environment. Digital TV and multicast IP represent the best processes to deliver multimedia content respectively through broadcast and Internet-based networks. Regarding broadcasting standards, Digital Video Broadcasting

[1] This work has been done within the TVMSL (*TéléVision Mobile Sans Limite*) project led by Alcatel-Lucent. This project plans to develop a DVB-SH standard suitable for hybrid satellite and terrestrial transmission. It is supported by the French innovation Agency OSEO.

P. Chatzimisios et al. (Eds.): MobiLight 2010, LNICST 45, pp. 710–721, 2010.

(DVB) is expected to be the prominent European television broadcast standard for the next decades, as well through a satellite-based technology (DVB-S) , as in terrestrial television (DVB-T), cable (DVB-C)or for hand-held devices (DVB-H). The DVB technology provides relatively high bandwidth data channels but based on uni-directionality, thus neglecting interactivity. DVB-SH, satellite services for hand-held devices, is a hybrid (satellite / terrestrial) architecture. It is defined as a system for IP based media content and data delivery for hand-held terminals, via satellite. Satellite transmission guarantees wide area coverage. Moreover, it is coupled with terrestrial gap fillers assuring service continuity in areas where the satellite signal cannot be received (built-up areas for example). DVB-SH provides users with a variety of services, which could be classified in several categories. It offers real-time applications. Examples are TV-like broadcasting, live broadcasting and notification, which consists in broadcast notifications sent according to the preferences of the user (notifying a football fan of the retransmission of his preferred team matches for instance) and games, like real-time quizzes or multi-player online role-playing games, etc. It also provides applications to download. For large general audiences, data file purchase services are offered, either on a subscription basis, such as downloading every morning the electronic version of the user's newspaper, or on an impulsive purchase basis, like for films, books and audio CD purchase. Besides, one of the main characteristics of the Internet world is its bidirectionality, permitting full interactivity to users. In this project, a DVB-SH broadcast network is combined with a 3G cellular network to ensure this bidirectionality. Actually, this convergence takes benefit from 3G and DVB networks. 3G network characteristics, especially upload link, enable added-value services and applications that are interactive and more personalized. DVB-SH is provided with a very high bandwidth capacity that allows unidirectional IP-TV channels broadcast. In our previous studies, we defined several scenarios of services where we switched 3G popular services over the DVB path [1,2].

In this paper, we propose a new scenario of service. We consider classical DVB channels, including TV programs and advertisements spots. We enhance such a TV service through the definition of personalized advertisements spots, that better fit user interests and localization. Obviously, advertisements are here given as an example of personalized service, but other types of contents can be proposed. In this scenario, the personalized content is sent over 3G, while the DVB content is still broadcasted. The terminal entity receives both contents, but plays only the personalized one. An important issue here will be the synchronization of flows to be read. The paper is organized as follows. The next section presents related work to DVB/3G inter-working. Section 3 describes the system architecture and the service scenario. The necessary signalization mechanisms are detailed in section 3.3. Section 4 validates our simulation of the scenario progress, and presents some observations and results. Section 5 proposes an enhancement of the scenario through the use of MBMS network, and its multicast broadcast capacities. Finally, section 6 draws our conclusion.

2 Related Work

Mobile advertising is a major applications of next generation networks. Advertisements could be customized based on user's location or on his main interests or on the TV programs he is watching.

Localized advertising covers the insertion of locally relevant advertisements. The goal is to provide users with advertisements concerning facilities in the nearer surrounding of their location [3], [4], [5]. In the currently deployed localized advertisement architectures, advertisements are generally ingested into a network accessible library and identified with a unique metadata. Standardized interfaces exist between this library of advertisements, the splicer, which is the equipment responsible of placing the advertisment in the video stream, and the scheduling server. At the appropriate time, the splicer inserts the local advertisement into the national feed [6].

Personalized advertisements can target the demographics associated with a household, a set-top or even an individual user. Search engines target advertisements based on search criteria a user enters. Retail web sites have long made suggestions for new products and services based on a user's previous order history, or on what others who have made similar purchases were also interested in, or on logical merchandising assumptions that suggest ancillary products.

Content based advertising are advertisements that target viewers based on their viewing patterns by advertising during certain programs or on certain networks. In this work, we take benefit of the coupling between DVB and 3G path to provide personalized TV contents, through 3G unicast. At first, we propose personalized advertisements based on user profiles, provided during the subscription process. Then, we propose localized advertisements thanks to a DVB-MBMS coupled networks.

3 Personalized Content Delivery Over a DVB-SH /3G Network

We consider a DVB TV channel proposed to users in two versions.

1. The Basic service: This is the "classical" DVB channel. The content is made of TV programs and advertisements which are broadcasted to all subscribers. In this service, the same advertisement spot is received by all users.
2. The Premium service: In this version of the service, the same TV programs are still broadcasted to users. However, during the advertisements, users receive advertisements sequences that correspond to their main interests. In this scenario, a user provides a profile that indicates his main interests when subscribing.

3.1 Architecture

In this scenario, we have chosen to consider personalized advertisements. Obviously, other customized services and contents could be proposed. The personalized contents are stored in 3G content servers. DVB-SH TV channel delivers Electronic Service Guide (ESG) messages announcing its programs and services. A mobile user receives the ESG messages and decides to subscribe to the TV channel. He can choose either the Basic or the Premium service. In this scenario, the user chooses to subscribe to the Premium version of the service. As a consequence, a subscription request and a user profile are delivered to the subscription module, through 3G uplink. The user profile indicates user's main interests.

In our approach, users have actually to choose from a list of possible interests. Their choice is transmitted to the subscription module, which is located in a Unicast Broadcast Router (UBR), as shown in figure 1. This router is the central equipment of our DVB-3G converged network. We designed this equipment to manage the DVB-3G network services (subscription, flow scheduling, signalization, synchronization, etc.). The UBR corresponds to the Service Management entity in DVB IP DataCast standard [8]. In our scenario the UBR contains the list of Premium service users and their interests. After subscription, the user starts receiving the broadcasted DVB channel. In this step, all subscribers (Basic ones and Premium ones) receive the same TV program, over the DVB path. On 3G side, there are several content servers, providing different content thematics.

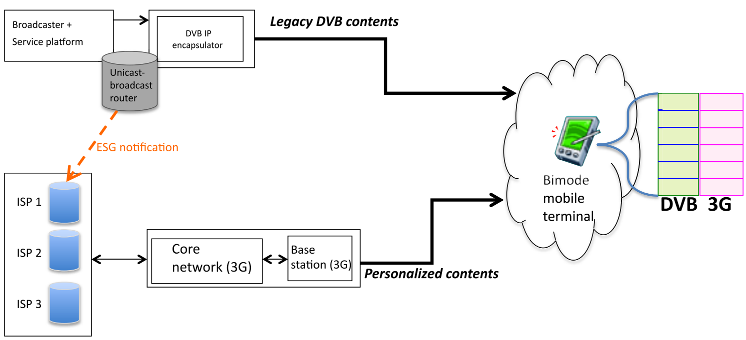

Fig. 1. Coupling DVB with 3G network

3.2 Scenario Processing

Before advertisement start, DVB server sends a notification message to each of its 3G personalized content servers. We use an ESG message for this notification, this point is discussed in section 3.3. This signalization message notifies of the scheduled time of the next advertisement. At advertisement time, the DVB TV program is interrupted and the DVB advertisement spot starts. Basic service mobile users receive and play this spot, in their terminal. Premium service mobile users continue receiving the DVB flow on their terminal. Actually, the reception of the DVB channel is not interrupted during the advertisement. At the same time, they receive and play a personalized advertisement through 3G unicast. The terminal receives both advertisements (the DVB one and the 3G one) but only plays the personalized 3G one. In this scenario, we assume that user terminal is bimode and manages two memory areas one for DVB flows and the other for 3G flows, as presented in figure 1. At advertisement start, the terminal player switches from the DVB memory area to the 3G one, so that it plays the personalized content. At advertisement end, the terminal returns back to playing its DVB memory area content.

Main problems. In this scenario, we have to treat several challenging issues. First, at least a part of the customized 3G advertisement should be available on terminal 3G memory area and ready to be played right on time. Then, the terminal player should possess an accurate and precise synchronization information in order to operate a smooth and seamless switching. Moreover, we had to define the appropriate signalization messages to ensure the communication between the different involved equipment and last but not least we had to consider the network scalability problems when the number of Premium users increases.

3.3 Definition of ESG Signalization

Service announcement message. DVB users receive all messages broadcasted over DVB, including ESG messages that announce the coming programs and services. Those are classical ESG XML messages [9], delivered over DVB-SH. In our scenario, they announce the coming programs. They also announce the possibility to subscribe either to the Basic version of the service or to the Premium version, with personalized content. Subscription requests are sent to the subscription module over 3G uplink. During the subscription process, Premium users are asked to deliver a user profile that indicates their main interests, in order to receive advertisements that best fit their expectations.

Advertisement transmission time message. After subscription, the service starts. The DVB programs start being broadcasted. The DVB operator sends a notification message to the 3G content servers to order advertisement transmission start. This order occurs slightly before advertisement scheduled playing time, as we take into account 3G transmission delays, in order to start the advertisement playing on time. Actually, at advertisement scheduled playing time, at least a part of the personalized advertisement is already in the terminal memory, ready to be played instantaneously. For this notification, we chose to use an ESG message. Actually, we studied the ESG XML structure and deduced that it provides the necessary fields for our message. An ESG message is structured as XML fragments [9], as shown in Figure 2. The Schedule Event Fragment is compound of several fields. In particular, the *ContentFragmentRef* field is used to reference a Content fragment, which describes the content available during this Schedule event. The schedule event fragment is the appropriate ESG fragment to be used to schedule our advertisement transmission start event.

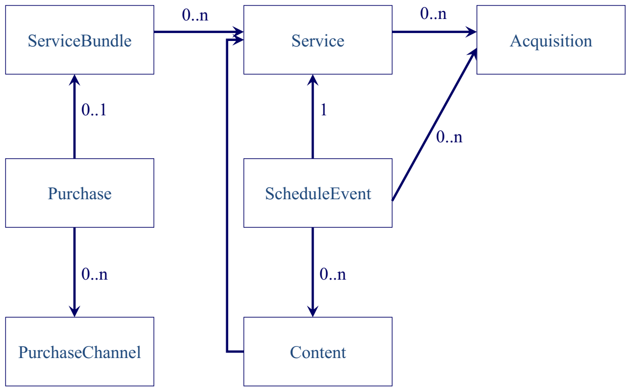

Fig. 2. ESG XML fragments

Synchronization information message. DVB operator also sends a signalization message to the mobile terminals. This message gives Premium service terminals the necessary information in order to play their flows and seamlessly switch between DVB content and 3G customized content playing, without service interruption. For this ESG message, the schedule event fragment could also be used to give the synchronization information and schedule the play switching event.

The terminals play their DVB program (that is received on their DVB memory area). Then, during the advertisement time, they continue to receive the DVB flow. However, they do not play it. They switch to their 3G memory area, where they have already received at least a part of the personalized advertisement (and the rest is being received). The 3G advertisement is played. At advertisement scheduled end time, terminals switch back playing the DVB content.

It is important here to operate a very smooth and precise switching, in order to make Premium users restart playing the DVB program at exactly the same moment as the Basic service users. Actually, it could be very disturbing to switch back to DVB playing when DVB advertisements are still being played, or when the DVB programs have restarted a while before.

We propose to use a marker in the DVB flow itself, that will design the exact frame where the switching has to occur. Our approach lead us to propose either the MPEG-2 TS Sync byte, which is a marker dedicated to synchronization or to give the number of the burst corresponding to the switching moment. In this context, we still have not a definitive choice and it is possible to investigate different fields that could provide the most accurate synchronization information.

4 Validation of the Scenario

For our simulations, we evaluated several tools, and we finally chose to use OPNET Academic edition simulator [7] since it is more adapted for realistic large-scale scenarios. Using OPNET, we have simulated the functional entities of our architecture. Indeed, the implementation of many components was needed, for example DVB content creation, ISP application server, UBR router, DVB/3G networks and mobile terminals.

4.1 Simulation and Results

On DVB side, a TV channel is broadcasted at 384 Kbits/s data rate.

On 3G side, there are several content servers where the personalized content are stored. Those servers receive the order from the DVB operator, to send the advertisements at the right time. The 3G contents are delivered at a 256 Kbits/s data rate. We chose this value as it represents the classical throughput offered to a 3G mobile user.

At simulation start, users receive the broadcasted ESG messages. They can subscribe to the DVB channel. They choose either the Basic service or the Premium one. Subscription requests are sent to the subscription module over 3G uplink. During the subscription process, Premium users provide a user profile that indicates their main interests, in order to receive advertisements that best fit their expectations. After subscription, the service starts. And the DVB program is broadcasted. The DVB operator sends a notification message to the 3G content servers to schedule advertisement transmission. Another ESG message is sent to the terminals. This synchronization message is presented in paragraph 3.3. At advertisement start, the DVB program is interrupted, and a DVB advertisement sequence is broadcasted to all users. The Basic service users receive and play the DVB advertisement. The Premium service users continue receiving the DVB flow. However, as they subscribed to the Premium service, they receive personalized advertisements through 3G. Thus, they use the synchronization information they had received, in order to switch to the personalized advertisement playing and then switch back to the DVB flow when the advertisement ends. Obviously, we consider advertisements with the same durations, for synchronization reasons. Figure 3 shows the flows received by a Premium service user terminal, respectively on DVB and on 3G dedicated memory areas. Effectively, DVB flow

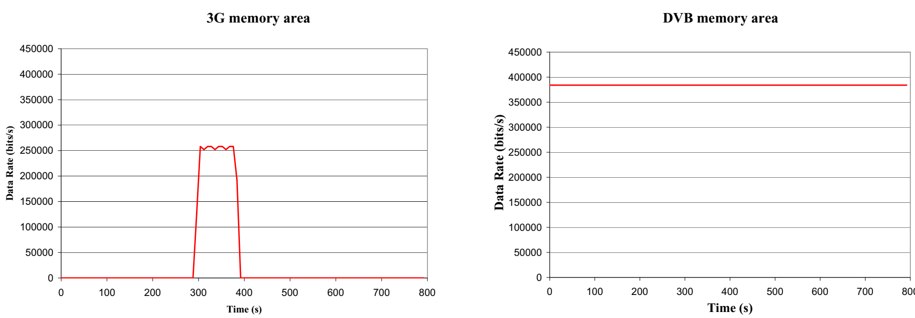

Fig. 3. Terminal received flows

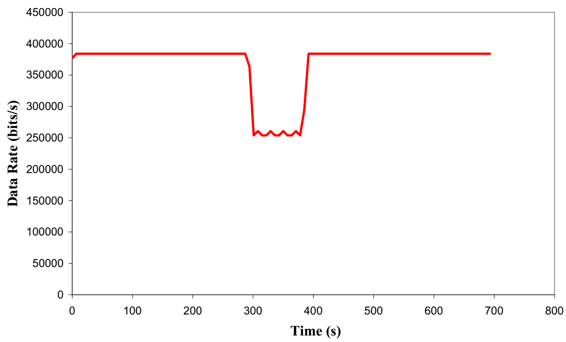

Fig. 4. Terminal player

reception does not stop during the advertisement sequence. The terminal receives simultaneously the DVB and the 3G advertisements. Actually, during the advertisement sequence, both DVB and 3G contents are received. However, during the advertisement time, the Premium user terminal plays only the 3G personalized advertisement. Figure 4 shows the flows played on the terminal player. Effectively, the terminal player operates a smooth and precise switching from DVB TV program playing to 3G personalized advertisment playing, thanks to the provided ESG synchronization information. Then, the terminal returns back playing the DVB TV program at the advertisment end.

4.2 Analysis of the Results

Implementing our scenario on OPNET simulation tool and running several simulations have permitted the functional validation of our scenario of service.

In this scenario, we proposed an interesting enhancement of our mobile TV service. In fact, in addition to the Basic version of the DVB mobile TV service with a general content adressed to all users and broadcasted over DVB path, we propose a Premium version of the service, available on a subscription basis. The TV programs are still provided over DVB, while, other customized contents are provided through 3G unicast. For instance, those contents could be advertisements. They are chosen based on the user profile, and sent in a 3G unicast mode.

An important criteria of scenario performance is the scalability of the service. So we progressively increased the percentage of Premium service users while evaluating the impact on 3G network performances. Of course, the deployment of customized advertisement service will lead to many 3G unicast connections. This deployment could prejudice 3G network performances. Actually, the 3G network provides our personalized advertisements in addition to its own services (FTP, HTTP, Mail, Voice, etc.). The delivery of personalized advertisement over the 3G path is not supposed to degrade the 3G network "legacy" services performances. The problem is that a 3G base station has a limited power. The maximum value of a Node B power transmission is generally of about 20 watts [10] [11].

Deploying more and more unicast connections to serve the customized contents leads to an over exploitation of 3G base station and can disturb the performances of 3G classical services, leading to congestions and even service disruption. So the current scenario is not scalable as is and necessitates several enhancements.

Looking further to our scenario principle led us to an important observation: In many cases, a group of users sharing the same location, have often similar interests. For example users can attend the same event (a concert), and so they are potentially interested in receiving information related with this event. As a consequence, it seems interesting to provide users with customized contents based on their location, rather than providing them with personalized contents based on their user profiles. Users sharing the same location will now receive the same content, thus reducing the number of deployed connections.

Starting from this observation, we decided to adapt our architecture to the new scenario need's. In the remainder of this paper, we couple our DVB-SH network with an MBMS network (Multimedia Broadcast Multicast Service). MBMS is an evolution of UMTS (UMTS release 6) [12]. Its offers an evolved 3G multicast broadcast solution over a 3G cellular network. The most important issue about MBMS is that it offers a fine grained localization capacity. This last property is very valuable in the context of our localized advertisement service as it will allow the delivery of one specific content per radio cell.

Premium service users, sharing the same location (i.e. same radio cell), are going to receive the same content. This content is tightly coupled to users location. This could be advertisment for the local hotels, restaurants and shops, or some tourism information or even advertisements for local music or sport event.

5 Localized Content Delivery Over a DVB-SH /MBMS Network

For the rest of our study, we coupled DVB-SH with a 3G-MBMS network, and we try to provide a different localized advertisement in each radio cell. Thanks to MBMS, we no more have to deploy many unicast connections to serve our users. We simply define multicast groups based on users' location. The advantage of MBMS is that it allows many receivers in the same radio cell to be served by a common signal transmission facility, or bearer, thus conserving radio resources (cf. figure 5).

5.1 Presentation of a MBMS Network

MBMS Multicast and Broadcast mechanisms. The main attraction of MBMS is that it allows many receivers in the same radio cell to be served by a common signal transmission facility, or bearer, thus conserving radio resources. This is not a new idea in UMTS.

MBMS uses IP multicast packets, that is, packets sent to a class D IP address, but the GGSN and SGSN send multicast packets only once to each downstream node. More importantly, packets are transmitted only once in each cell, at least

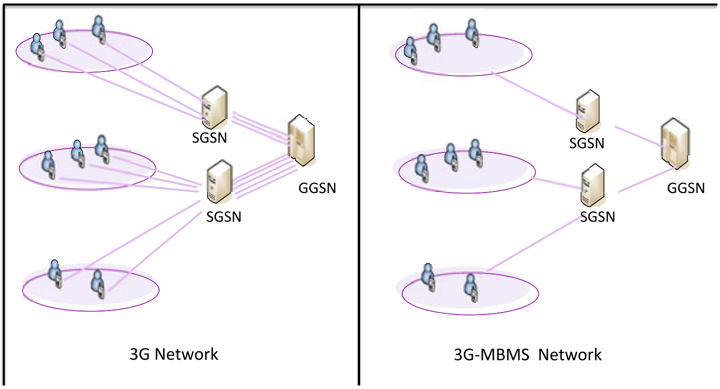

Fig. 5. IP multicast with MBMS

when a sufficient number of intended receivers is present there. In fact, while MBMS can potentially provide considerable savings in transmission bandwidth over the air, it incurs considerable signaling overhead and may not even make sense for small numbers of users.

MBMS architecture. The Broadcast/Multicast Service Center (BM-SC)is the new functional entity added to the packet switching domain of the UMTS core network. It plays a mediating role between the content providers and the UMTS network, as shown in Figure 6. The BM-SC is responsible for both the control and user planes of an MBMS service. It is also responsible for authenticating and authorizing the content providers, receiving and possibly modifying their data. For instance, it encryptes and passes these data to the GGSN for transmission. The BMSC may repeat a whole data transmission or specific parts of it for error recovery purposes. It also brings information about its services for service announcement and bearer setup purposes. Moreover, it screens the UEs wishing to join a multicast session to verify whether they have subscribed to the service. Then, it initiates the session start and stop phases.

MBMS, not only adds a new node to the UMTS architecture, but also requires modifications to existing nodes.

The Gateway GPRS Support Node (GGSN) is responsible for transmitting data via tunnels to the appropriate Serving GPRS Support Nodes (SGSN), that is, all SGSNs in the case of broadcast services or only those SGSNs serving group members for multicast services. The SGSN sends these data via tunnels to the appropriate RNCs or BSCs, depending on whether the UTRAN or the GERAN is used. During the session start phase, the SGSN instructs the RAN to establish actual radio bearers. Then, during the session stop phase, it instructs the RAN to release the actual radio bearers [12]. Finally, the User Equipment (UE) is responsible for joining and leaving multicast services and for enabling or disabling broadcast services. It also has additional application specific tasks, like media playback for example.

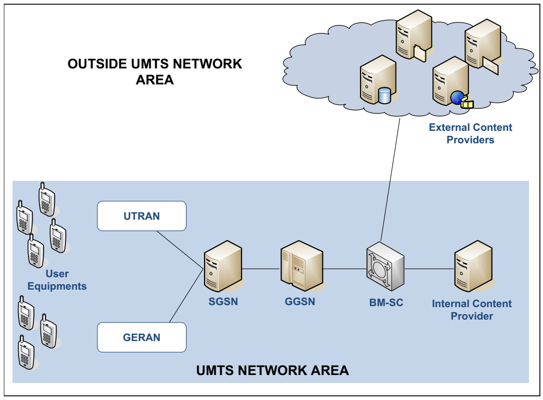

Fig. 6. MBMS architecture

5.2 Simulation and Main Results

OPNET simulation tool provides an implementation of UMTS, but does not implement MBMS network. For our simulations, we used an OPNET implementation of MBMS network, which was developed in the framework of B-BONE European project [16]. For this new simulation, we maintain the simulation parameters used in section 4.

Let us focus on one MBMS radio cell. Mobile users are moving in the cell at varying speeds. Terminals are bimode. They receive the DVB TV programs. They also receive 3G legacy services (email, FTP, HTTP, etc.). Some of them may be Premium users of our TV service. Those ones will receive the localized video at advertisment scheduled time. In our simulations, we increase the number of Premium service users and study the impact of MBMS network use on our scenario performances. As expected, MBMS deploys only one multicast connection per radio cell, to deliver the local advertisment. Thus, each Premium user benefits of an advertisment adapted to his location, and 3G network performances are preserved as we no more deploy numerous unicast connections for our service.

6 Conclusion

In this paper, we specified the basis for the deployment of customized services over DVB-SH / 3G coupled network. The main idea was to punctually replace DVB-SH legacy programs by 3G contents, that better fit users' needs and interests. This substitution is managed by the terminal, and the synchronization is processed using specific ESG messages. The problem with such a service is its scalability, considering the risks of saturating 3G network with the unicast delivery of personalized contents. As a solution to this problem, we proposed to use MBMS services, that provide multicast/broadcast mechanism on a 3G network. Thanks to MBMS, we replace the personalized advertisements delivered via 3G unicast by localized contents offered via multicast, thus preserving the performances of 3G network legacy services.

References

1. Jedidi, A., Tlais, M., Weis, F.: Coupling 3G with DVB Networks for Low Cost Services. In: 3rd International Conference on Engineering Management and Service Sciences, Special Session on Media Interactivity and Network Convergence, Beijing, China (September 2009)
2. Jedidi, A., Tlais, M., Weis, F., Kerboeuf, S.: Efficient Switched Services over a DVB-SH/3G Network. In: 5th International Mobile Multimedia Communications Conference, London, UK (September 2009)
3. Aalto, L., Göthlin, N., Korhonenm, J., Ojala: Bluetooth and WAP Push based location aware mobile advertising system. In: MobiSYS 2004 Proceedings of the 2nd international conference on Mobile systems, applications and services, Boston, USA (2004)
4. Kolmel, B., Alexakis, S.: Location based advertising. In: Proceedings of the 1st international conference on mobile business, Athens, Greece (2002)
5. Ververidis, C., Polyzos, G.: Mobile marketing using a location based service. In: Proceedings of the 1st international conference on mobile business, Athens, Greece (2002)
6. UDCAST: DVB-H mobile tv flexible satellite distribution, European Standard ETR 154 (January 2007)
7. http://www.opnet.com
8. EBU/ETSI: Digital Video Broadcasting (DVB) IP datacast over DVB-H: Architecture, European Standard ETSI TR 102 469
9. DVB IP DataCast over DVB-H Electronic Service Guide (ESG), DVB Document A099 Rev.1 (September 2008)
10. Alexiou, A., Bouras, C., Kokkinos, V.: Evaluation of different powersaving techniques for MBMS services (October 2008)
11. http://www.sante.gouv.fr/htm/actu/telephonemobile070201/dplieux.htm
12. Xylomenos, G., Vogkas, V., Thanos, G.: The Multimedia Broadcast/Multicast Service. Wireless communications and mobile computing 8(2), 255–265 (2008), ISSN 1530-8669
13. Annamalai, M.: Multimedia Broadcast Multicast Service (MBMS) in GSM based wireless networks, T-mobile USA, Technical report (April 2004)
14. 3GPP: Multimedia Broadcast/Multicast Service (MBMS) user services; Stage 1, V6.2.0 (2004)
15. 3GPP: Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs, V6.2.0 (2005)
16. MBMS System Level Simulator, http://b-bone.ptinovacao.pt/