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Adaptation and Personalisation of Interactive Mobile TV Services

Mobile TV is now considered to be one of the most promising technologies by telecommunications operators, broadcasters and content providers. However, at this stage, mobile broadcasting is perceived as either an opportunity or a risk for telecom operators, depending on the way both networks (telecom and broadcast networks) will be used in the service delivery.

The deployment of rich media technologies in an open and flexible service delivery environment will enable an efficient co-operation between both types of network and will be the source of new revenues. This article presents use cases, technologies and a functional architecture supporting the adaptation and personalisation of interactive mobile TV services.

Introduction

Mobile TV is now considered to be one of the key growth areas for telecom operators, broadcasters and content providers. Mobile broadcast technologies, such as satellite – digital multimedia broadcast (S-DMB) and digital video broadcast (handheld and satellite) (DVB-H, DVB-SH) are appearing in the mobile network landscape with promising commercial prospects. The basic service is to broadcast TV on mobile phones. In addition to that, interactive services will be provided with these broadcast TV services, such as betting, voting, purchasing, personalised data downloading (text, video, ring tones, advertising, etc). The fact that the end-user handset is a mobile phone will provide a back channel (e.g. 2G/3G channel).

However, mobile broadcasting is perceived as either an opportunity or a risk for telecom operators depending on the way both telecom and broadcast networks will be used in the service delivery. There is a risk that revenues of telecom operators will decrease because end users will be watching the TV instead of using telecom services.

However, an efficient co-operation of the broadcast and mobile networks (Figure 1) resulting in the creation of new services will be the source of new revenue. In mobile networks, it is expected that these new services will induce profitable interactive requests from end users.

For this purpose, rich media is a key technology as it enhances video flows, notably for multimedia data and interactive services. Rich media will allow mobile TV to become interactive for voting services, games, content access or other communication and community services, such as instant messaging (IM) or chatting. The use of a rich media technology creates a synergy between the broadcast network and the unicast network (as the back channel uses the unicast network) generating new revenues.

In this context of delivering interactive mobile TV, we present the results of our study into a solution enabling the personalisation and adaptation of interactive mobile TV services according to an end-user's profile, localisation, or type of terminal. As different users have different information needs, types of service that one user finds extremely valuable may be of little use to another, i.e. relevance is a highly subjective notion.

By providing services closer to end-user expectations and usages, the service providers will increase their average revenue per user (ARPU), their customer loyalty, and it will also be a key differentiator in the market-place.

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Use Cases

Adaptation and personalisation open up the possibility of creating a wide range of new and attractive services. A broadcaster sends the same TV programme to the end users and the terminals display differentiated interactive services. The personalisation and adaptation can be done according to the user profile (gender, age, social category, area of interest, TV programmes watched, most frequently service used, terminal characteristics, etc) and the localisation.

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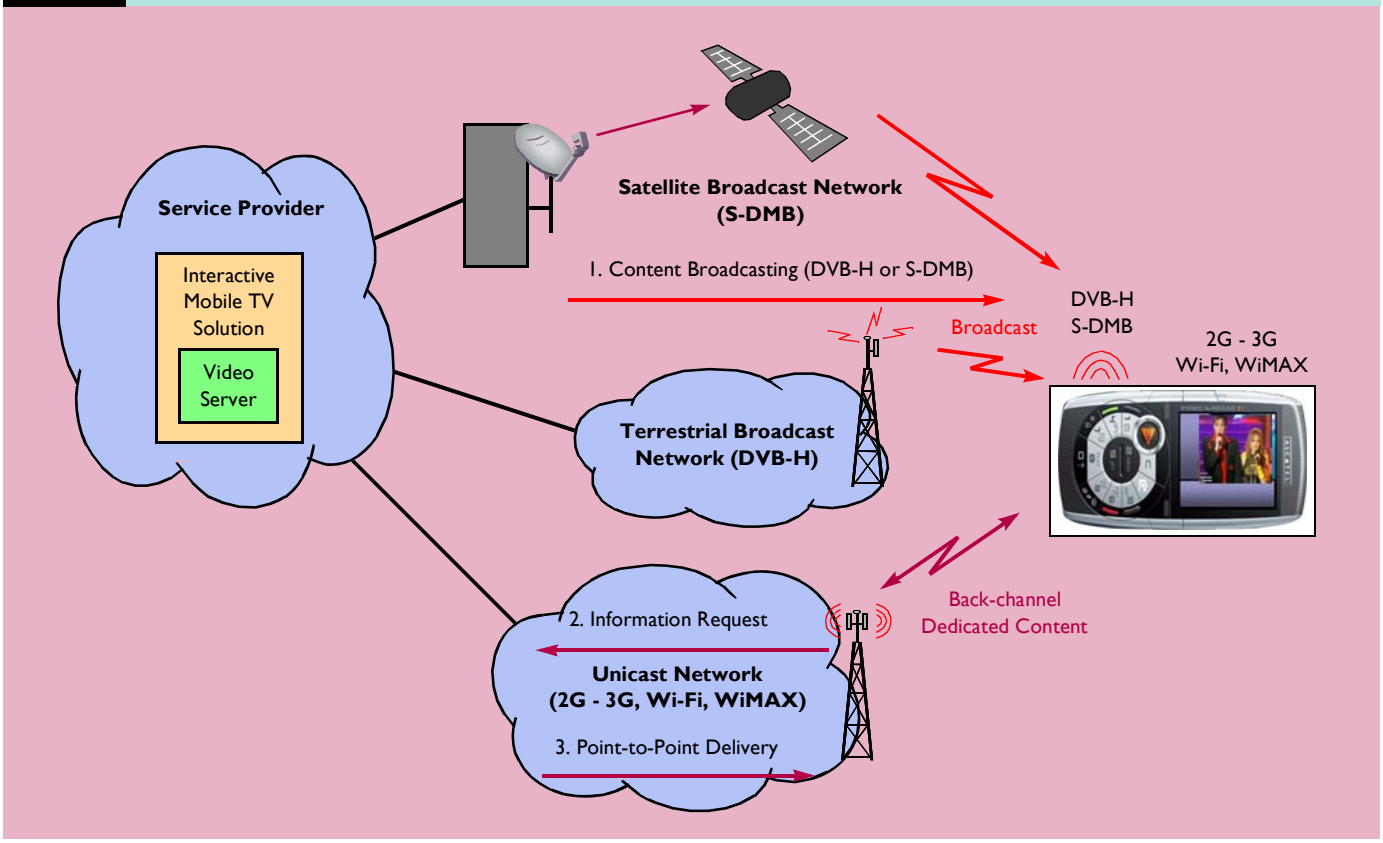
Figure 1 Co-operation between unicast and broadcast networks



Horizontal and vertical service personalisation

Some examples of common personalised and adapted interactive services are listed below.

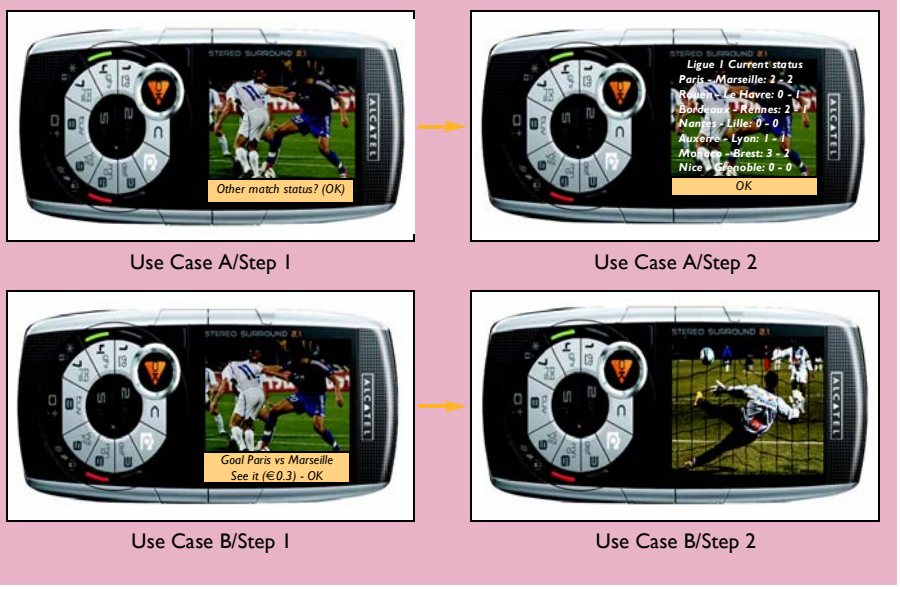
- Betting services
  For instance, betting services are only offered to adults or to people that are used to betting.
- Voting services
  For instance, only those votes/questions that best fit the end-user profile are proposed.
- Advertising services
  An interactive advertising campaign is personalised in order to have a better impact on the end users. A basic example could be where, during a car manufacturer's advertising campaign, personalised links will be suggested to car type information that best fits the end-user profile.
- Shopping services
  A basic example could be to propose to the end users different products to buy according to the end user's profile, localisation or context (e.g. noise, mood, activities, place). In this case, the personalised shopping service will increase the chances of a sale.

The personalisation can either be done in a horizontal manner (e.g. the same service is personalised) or in a vertical manner (e.g. different services are proposed). The above services are all examples of horizontal personalisation. Vertical personalisation is where heterogeneous services are proposed, targeting end-user profiles. For instance, during the same TV show an interactive advertising service is offered to one specific group of end users, while an interactive shopping service is offered to another group of end users. In both cases, the objective is to present the most relevant service or specific information available to the end user, according to the end-user profile, the localisation, the context or the service usage.

All-in-one concept

As an example, Figure 2 provides two use cases of common interactivity in the context of a football match viewed on a mobile phone. In the use case A, the user is offered the chance to see the results of the other ongoing matches (step 1). If the user presses OK, the results are over-displayed (step 2).

Figure 2 Some interactive mobile TV use cases



Use Case A/Step 1 | Use Case A/Step 2

Use Case B/Step 1 | Use Case B/Step 2

In the use case B, the user is offered the chance to see the goal of another match that has just occurred at the same moment (step 1).

In the same way, the goal sequence is visualised if the user presses OK (step 2), but in this case is charged €0.3.

One key advantage of such interactive mobile services is the 'all-in-one' concept as the same device is used for viewing the video and facilitating the interactivity. 'All-in-one' drastically improves the service's ease-of-use.

Technology Overview

Rich media format

One crucial point is the choice of the rich media format that allows the interactivity to be provided with appropriate personalisation and adaptation. To do that, a list of criteria must be taken into account:

- proprietary or standard format;
- format widely used or with a limited audience;
- number of solutions/companies supporting the format – risks occur if only one format is supported by only one company;
- long-term existence of the associated solutions;
- digital rights management (DRM) aspects;
- the regulation aspects – in Europe, it is the public authorities that choose the broadcast format.

Some vendors may claim their solution is cheaper since they are a 'one-stop shop'. Yet, to use an open standard avoids the dangerous hidden costs of proprietary technology.

Out of all the rich media technologies – X3D[1], Synchronised Multimedia Integration Language (SMIL)[2], Scalable Vector Graphics (SVG)[3], MPEG4 Binary Format for Scenes (BIFS)[4], MPEG LASeR[5], QuickTime[6], Windows Media[7], RealMedia[8] and Flash[9] – three of them look promising: MPEG LASeR, MPEG4/BIFS, and Windows Media. They all have advantages and drawbacks. MPEG LASeR is ready-to-use but through only one solution (with the Streamezzo products – www.streamezzo.com); Windows Media is a *de facto* standard but proprietary and with a limited flexibility; MPEG4/BIFS is a standard but the players for mobile devices are not yet totally mature. Figure 3 gives an overview of the rich media formats, players, servers and authoring tools.

The rich media format for DMB is MPEG-4 with BIFS. Yet, the choice of the rich media format is still open for DVB-H in many countries.

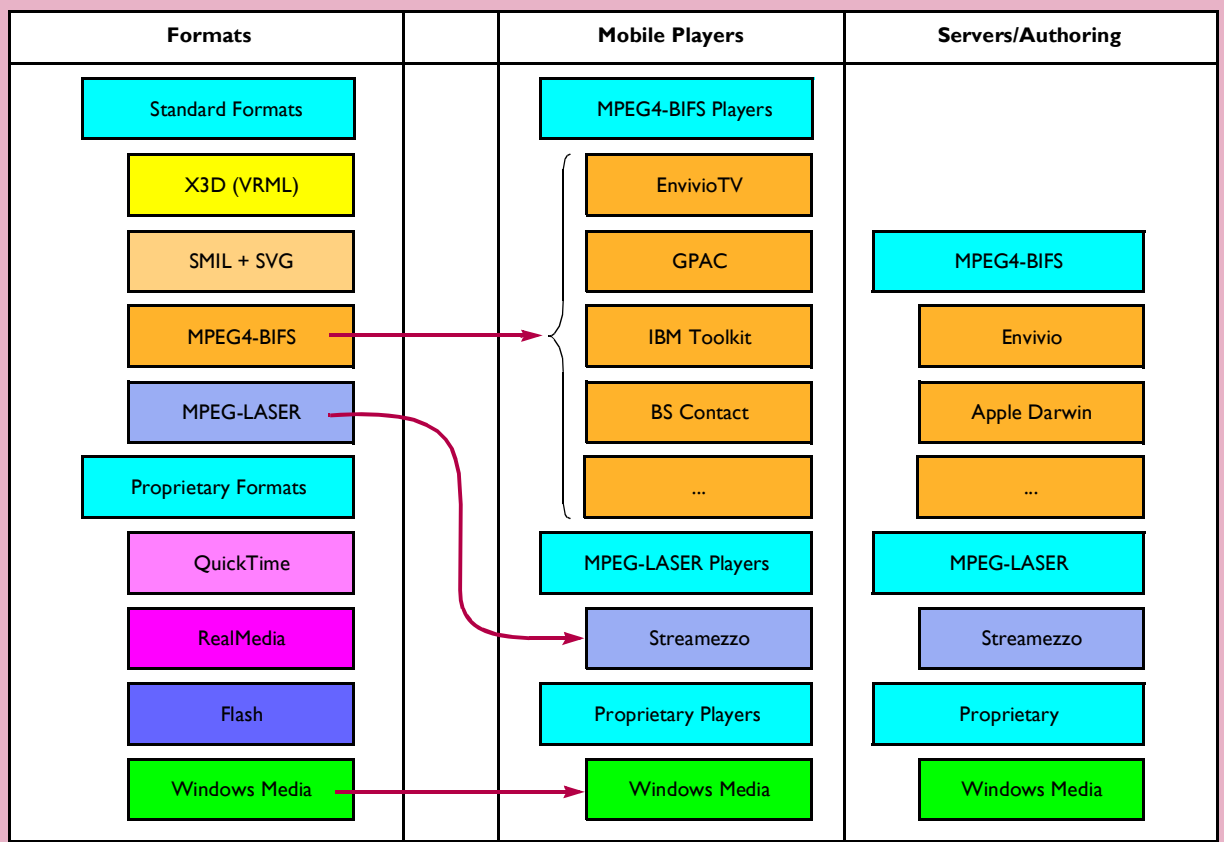
The rich media format is the way to render interactivity. An important aspect associated with rich media is DRM that allows securing and protection of the content delivered to end users.

Digital rights management

Broadcast content and on-demand content must protect the intellectual property copyright. A DRM solution must therefore be deployed to control the rights for viewing and copying. DRM solutions will affect the architecture of interactive mobile TV services solutions because some DRM solutions are independent of the rich media format and others are included in the encoding format.

Standard or proprietary DRM solutions exist. For example, a SIM card is a solution that enables end users to be identified so that personalised services can be offered. The DRM proposed by the Open Mobile Alliance[14] may involve control of the SIM

Figure 3 Rich media formats, players and servers



number, and may also involve controls based on the advanced functions of the SIM card.

Standardised DRM solutions allow interoperability and facilitate roaming between heterogeneous networks. With these solutions, users have the chance to access, within visited networks (broadcast networks/2G-3G), their preferred programmes on the basis of inter-operator agreements.

The rich media format DRM solution must be integrated into an overall solution that permits the creation, management and playing of interactive mobile TV services with all the protection required by the content providers.

Personalisation data and algorithms

After rich media and DRM, the remaining important points are the data and the algorithms allowing the personalisation. Many working groups exist in relevant standardisation bodies, such as 3GPP (GUP, LCS and Presence)[10], W3C (CC/PP)[11], ISO (MPEG-7/21)[12], Liberty Alliance (Federated Network Identity)[13], OMA (UAProf, Mobile Web Services, Wireless Village)[14] and Parlay/OSA. Table 1 gives an overview of the relevant bodies and their coverage.

In the context of mobility, and with the back channel being able to use different technologies (such as 2G/3G), the GUP concept coming from the 3GPP Forum seems to be promising.

Personalisation is also one of the main areas of study covered in EU projects such as Daidalos[15], ePerSpace[16], Wireless World Initiative (WWI)[17] and Mobilife[18] and Eurescom project P1308 (Frapesa[19]). Table 2 gives an overview of these EU projects.

The ePerSpace project defines the principal objective of personalisation as tailoring products and services to user needs, providing the correct service/content to the right person at the right moment, over an acceptable channel.

The other major elemens of personalisation and adaptation are the algorithms or the processing used to run them. Personalisation is based on the analysis and processing of user profile data and service use. Many techniques and algorithms exist[20] and each one has advantages and disadvantages depending on the required analysis. Table 3 provides a summary of the existing algorithms.

The choice of the right algorithm for personalisation is not easy. Yet, an 'expert system' applying rules/policies defined by operators would appear to be a better solution to deploy, and a good compromise.

Interactive Mobile TV Services Solution Architecture

Interactive mobile TV landscape

The business landscape is complex as there is presently a churn of technologies and business actors trying to find their way towards a well-balanced ecosystem for this emerging industry. At the present time, several business models are being considered[21] and there is a degree of uncertainty about the final model that will be deployed (division of service revenues among mobile operators, broadcast operators, content providers and advertisers).

Figure 4 depicts an example of the business model that the solution must support. In this model, the cellular provider manages the end users and controls the service provisioning.

Regarding the business landscape, there are several actors already involved:

- broadcasters who provide TV channels, and aggregators who bundle these channels into clusters;
- broadcast network operators who provide access to their own broadcast networks (terrestrial, satellite or cable) to deliver the TV channels or clusters to end users;
- mobile operators (operating a cellular network) and mobile service providers (operating a mobile portal) who are currently offering mobile TV programmes in a unicast mode;
- other actors such as content providers (movie or programme producers), advertisers or even access service providers (ASPs)/Internet service providers (ISPs) who directly provide content to be delivered through the network.

In the technology landscape, several aspects have to be considered:

- mobile broadcast technologies could be terrestrial (DVB-H, T-DMB, MBMS), satellite (S-DMB) or hybrid satellite/terrestrial (DVB-SH);
- the frequencies that can be allocated to the mobile TV channels depend on the regulation rules of each country – available frequencies are a critical resource that may have a strong impact in the selection of the broadcast technologies;
- the unicast network, used for the back channel to get the requested content once the interactivity is triggered, can be a GPRS/EDGE, 3G or upcoming WiMAX network;
- some other critical technologies, such as DRM, are mandatory for content providers to deliver their added value content safely in the network.

At the network level, the mobile broadcast landscape is still shifting as the technical, regulatory and business choices have not yet been made and could also be country dependent.

Therefore, to reduce the integration costs of the solution by avoiding specific assimilations for each business model, the architecture must be flexible and based on standardised interfaces.

Table 1 Forum coverage summary

Forum	Coverage
3GPP	– Specifies profiles, profile management, context and presence and availability. – The user profile is specified by the means of the generic user profile (GUP) concept. – Provides location services (LCS) and presence specifications for personalised and context aware services.
W3C	– The Device Independence working group defines a profile that is a description of device capabilities and user preferences.
ISO	– Personalisation is defined through work done on MEPG 7 and MPEG 21 standards. – Defines profiles, profiles management, service adaptation, context, security and privacy.
Liberty Alliance	– Concept of the Federated Network Identity. – Specifies profiles and profiles management, security, and privacy.
OMA	– Reference activities on personalisation and profile are those from the OMA BAC UAProf and OMA mobile Web services working groups. – Specify service discovery, context, presence and availability, rules and rules engine, security and privacy.
Other	– Parlay/OSA specifies service discovery, context, presence and availability, and security and privacy.

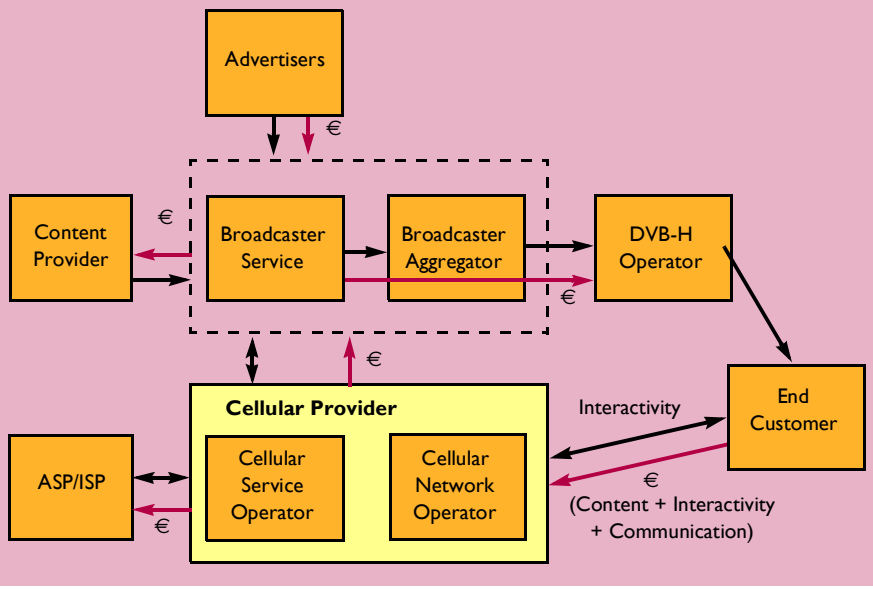
Table 2 European project coverage

Project	Coverage
IST Daidalos project	– Designs, delivers and manages location-independent and optimised personal services. – Deals with service discovery, service adaptation, context, security and privacy.
Eurescom Frapesa project	– Builds a framework for the personalisation of services and application in next generation services. – Deals with profiles, service adaptation and context.
IST Mobilife project	– Brings advances in mobile applications and services within the reach of users in their everyday life. – Deals with profile management, context, presence and availability, security and privacy.
IST ePerSpace	– Proposes a path for personalised services at home and anywhere starting with the user needs. – Deals with profiles, profile management, service discovery, service adaptation, context, presence and availability, rules and rule engine, security and privacy.

Table 3 Personalisation algorithms

Techniques	Advantages	Disadvantages
Clustering	– Can provide dynamic recommendations based on user behaviour	– Inefficiency of the algorithm when the number of items becomes very large
Similarity-based techniques	– Provides ranked results – Efficient even when user's need is fuzzy or the number of features is very large	– Can be inefficient when the feature of user's need is very simple and exact
Boolean filtering	– Easy to understand for simple queries with clean formalism – Reasonable efficient implementations for normal queries	– Too rigid – Difficult to express complex user request – Difficult to control the number of programs filtered – Cannot rank the output
Association rules	– Provides both categorical and quantiative rules	– A large number of rules can be produced but many of them may not be interesting
Classification	– Provides both categorical and quantitative classifications – Several direct applications in target marketing and eCommerce	– Inefficient when the data becomes sparse

Figure 4 Example of business model



Functional architecture

A functional architecture is proposed to support the personalisation of service applications. Domains were identified by the BCAST group of the OMA[14]. They name it 'Logical Entity'. A similar approach is being followed in the DVB-CBMS group of the DVB Forum[22].

In our functional architecture, the 'service personalisation' utility enables the application to personalise services delivered to end users, such as the service guide, the file delivery or interactive services (e.g. voting, betting, shopping services) starting from end-user profiles, usage analysis or optionally from localisation information. Figure 5 illustrates this functional architecture.

The main functions comprising the service personalisation architecture are, at the 'terminal' level:

- the 'Service and Content Agent' which is in charge of:

  – filtering the personalised services according to a local user profile, interacting with the 'Local Service Personalisation';

  – interacting with the 'Interactivity Handler' in order to personalise services at the server level;

  – interacting with the 'Service Personalisation' via the 'Interactivity Handler' in order to define or update the end-user profile (local or distant);

- the 'Local Service Personalisation' is in charge of managing and updating the local user profile – the user profile can be stored locally in the end-user handset or at the server level (remote) (the operator or the end user can update the local or remote user profile automatically or on demand, or the local user profile can be automatically updated according to the end-user service usage);

and, at the 'Service Application' level:

- the 'Interactivity Handler' is responsible for serving and managing interactive services that are either personalised or not, delivering services, receiving end-user requests and responding to end-user requests;
- the 'Service Application' is the generic name for the module that manages specific services such as interactive shopping, voting, etc, enabling personalised interactive services by interacting with the 'Service Personalisation' – the 'Service Application' interacts with all the other modules that are used to build the service delivered to the end user;

- the 'Service Personalisation' is in charge of managing the service personalisation, receiving requests from the 'Services Applications' and interacting with the 'User Profiles Manager', 'Service Subscription', 'Home Subscriber Server' (HSS), 'Home Location Register' (HLR), or 'Localisation' in order to analyse and characterise the end-user profile and service usage;
- the 'External User Profiles Databases' function is used to manage end-user profiles at the service level, creating, storing, retrieving, and updating end-user profiles stored in one or several databases – it can update user profiles from service usage analysis.

IP multimedia subsystem context integration

In the context of mobility and considering the telecom network evolution, the solution providing the service personalisation function will have to support the IP multimedia subsystem (IMS). In an IMS, the media server (also called MRF – multimedia resource function) processes media streams for network-based services. Media stream processing includes such functions as playing announcements, collecting dual tone multi-frequency (DTMF) digits, audio recording and playback, bridging multiple streams (also known as conferencing), speech recognition, text-to-speech rendering, and video processing.

In performing these functions, the media server always operates under the direct control of an 'application server' (AS). The AS provides a service execution environment, application-specific logic, and all the signalling required for one or more services. The media server performs all the media processing for the service(s).

By integrating an 'MRF adapter' in the system, the interactive mobile TV solution can be used like a media server from the point of view of the SIP application server. The end users will be able to access the interactive content delivered by interactive mobile solutions with a basic 'IMS phone'.

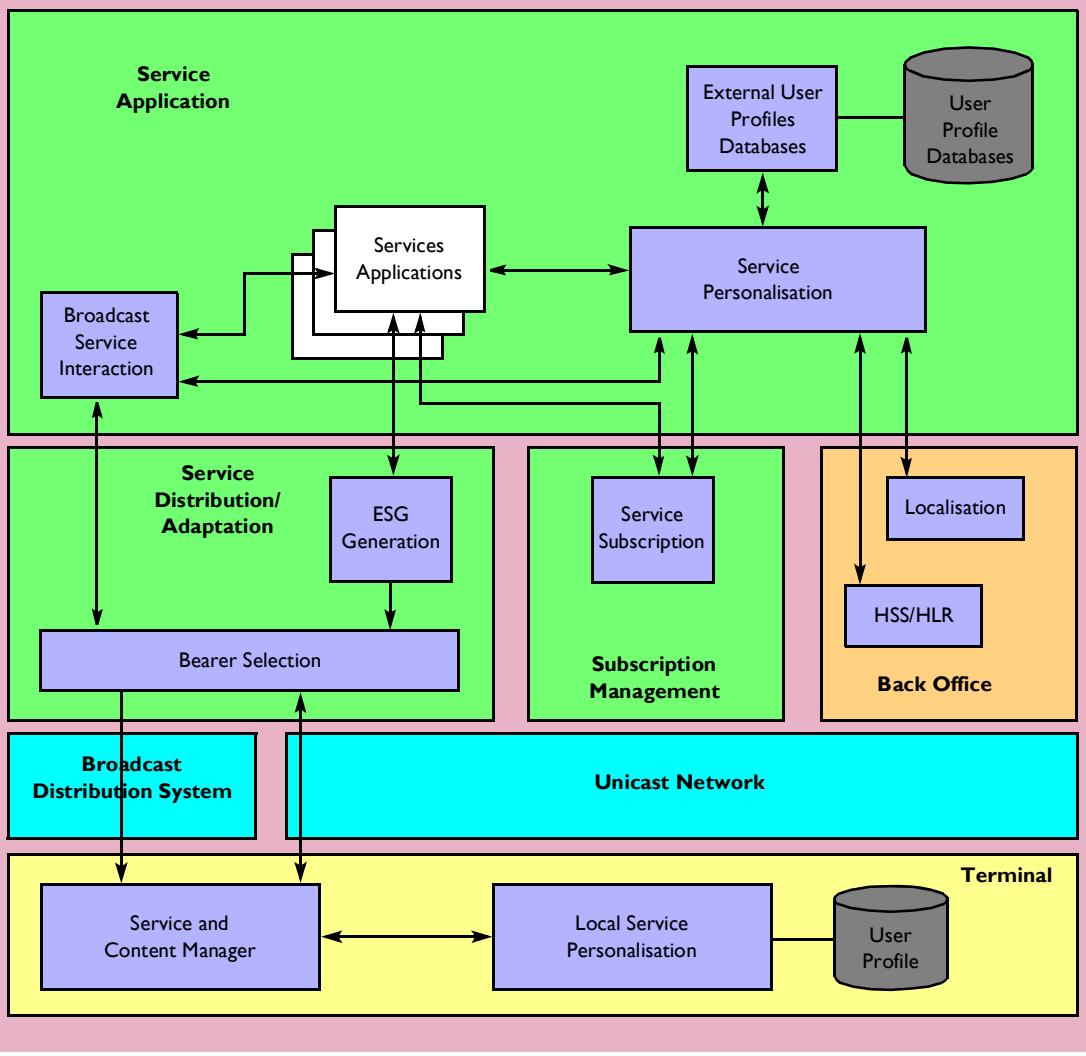
Conclusions

User trials are ongoing for mobile TV in Finland, Germany, France and several other countries. The first results are positive – customers seem ready to pay for such services. So there would appear to be a market for interactive mobile TV.

However, the choice about which rich media technology, the decision about frequencies, the business models that will be applied and the final end-user acceptance, are all still open. Several solutions already exist, however, for providing a high level of interactivity for a wide range of terminals.

The key conclusion is that the platform that delivers interactive mobile TV services

Figure 5 Basic architecture rendering the service personalisation function



must be flexible, able to operate regardless of the technology used for the broadcast network (S-DMB, DVB-H, DVB-SH, etc), and support various rich media formats, user profile data and business models (depending on national regulations/rules). Personalisation will be an important functionality that will make the adoption of new services by end users more easy and therefore increase the operator ARPU. Service platforms and end-user terminals must be able to support all these features.

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Emmanuel Marilly is a research engineer at the Research and Innovation Department of Alcatel-Lucent France. He received a PhD in Computer Science from the University of Le Havre (1999). From 1999 to 2000, he was assistant professor in computer science at the University of Le Havre. Since 2000, he has been with Alcatel-Lucent R&I. He is an expert for the French National Association for Research (ANR) in the area of audiovisual and multimedia. His research interests include network and service diagnosis, service management, co-operative platforms, fixed/mobile network convergence, interactive mobile TV, proximity and community applications.

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He joined Alcatel-Lucent in 1998, in the Research and Innovation department. After several years on network management and service assurance, he has been responsible for the broadcast mobile TV activity, focusing on the possibility of introducing added-value features like interactivity or personalisation, for the last two years.

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Stéphane Betgé-Brezetz received his engineering diploma from École des Hautes Études Industrielles of Lille in 1991 and a PhD in computer science from Toulouse University (LAAS-CNRS) in 1996. He joined the Alcatel-Lucent Research and Innovation department in Marcoussis and has been responsible for research studies on middleware technologies, software architecture and service and network management. He has been involved and has led several research projects (RNRT, ITEA) and academic collaborations (with INRIA, CNRS). Presently, he is responsible for a research team working on service delivery platforms and his main topics of interest include platform enablers, user profiling, and service personalisation for converged fixed and mobile networks.

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