Proceedings of I-KNOW '08 and I-MEDIA '08
Graz, Austria, September 3-5, 2008

Aggregation and Personalization of Infotainment – An Architecture Illustrated with a Collaborative Scenario

Stéphane Turlier, Benoit Huet
(Institut Telecom – EURECOM, Sophia-Antipolis, France
{Stephane.Turlier; Benoit.Huet}@eurecom.fr)

Thomas Helbig, Hans-Jörg Vögel
(BMW Group Forschung und Technik, Munich, Germany
{Thomas.Helbig; Hans-Joerg.Voegel}@bmw.de)

Abstract: A user-centric architecture of infotainment content adaptation to the context is presented. The architecture uses component technologies in term of business logic and functionalities offered by social web (OpenID, FOAF) and semantic descriptions of MPEG-7 and MPEG-21. Technological alternatives are discussed and adapted to the specificity of vehicle applications in terms of scalability and platform mobility. The requirements of the architecture are motivated by the presentation of a scenario.
Key Words: MPEG-7, MPEG-21, FOAF, OpenID, content-based Multimedia Retrieval, Hypermedia systems, Web-based services, XML, Semantic Web, Vehicle
Category: H.1.2, H.3.1, H.3.3, H.3.5, H.3.6, H.5.1, H.5.4

1 Introduction

The increasing amount of metadata describing multimedia content makes possible the personalization of the multimedia experience. Different approaches of music recommender systems based on description metadata have been proposed mainly on music-centric approaches. However, to our knowledge, no architecture addresses the problem of delivering audio cross-media content in a user-centric approach. The goal of this article is to show how the combination of multimedia description and semantic user descriptions can lead in a proper architecture to propose a more user-centric approach of multimedia personalization and to explain how it can be used in a collaborative scenario.

2 An automotive scenario of collaborative filtering

In order to identify the requirements of the architecture, we imagined this scenario: *Andreas, Barbara and Christopher are a group of friends who want to go together to some sea resort on the coast for the week-end. Andreas proposed to Barbara and Christopher to use his car for the journey. When driving, they would like to enjoy a personalized entertainment program matching their preferences.*

Step 1: *Each of them has at least one profile containing preferences and this profile is accessible online. In their preferences they specify the type of content they like to listen to. Andreas likes listening to classical music and jazz, world news and sport news whereas Barbara prefers rock music, daily national news and Christopher also likes rock music and wants to hear every hour the stock-exchange variations. Christopher hates classical music, while Andreas is not really keen on stock-exchange market.*
Step 2: *Andreas, Barbara and Christopher start driving. During their journey they have to cross various regions from urban environments to mountains and the availability and the quality of the wireless service is changing. The multimedia system adapts its selection of resources depending on their availability.*
Step 4: *Andreas, Barbara and Christopher start a discussion; in order to be able to understand one another properly they want the multimedia system to lower the volume and to avoid playing back spoken content.*
Step 3: *The road mates want to keep track of their infotainment experience as a group. They may want to bind their profiles and to mark their common interest in order to refine the personalization of their return journey together.*

3 Infotainment available metadata are heterogeneous

In order to adapt infotainment to the user, a good knowledge of the content is necessary. A description standard like MPEG-7 provides an extensive framework even if it has still few commercial applications. However a wide range of multimedia content is now reachable from a vehicle but available metadata are unequal depending on the kind of source.

3.1 Live broadcasted content (Push-Paradigm)

3.1.1 Analogue sources

Historically, live content (push paradigm) available by analog radio was the first type of media content available in the cars. Today the excellent coverage by AM and FM radio of most of territories makes possible the delivery of infotainment very easily and everywhere. Even if originally now metadata was provided by traditional FM radios, RDS makes possible to identify them and to change dynamically frequency when moving, more over new techniques like RadioText Plus [RDSForum 2005] provides metadata like the title and the name of the artist currently being played.

3.1.2 Digital sources

The digital standards like DAB-H, DVB-SH or T-DMB widen the diversity of available live programs and enable the distribution of description metadata along with them. However, as analog broadcasted sources, digital broadcasted sources do not provide any sort of personalization and are delivered on an inflexible timely fashion.

3.2 On-Demand available content (Pull-Paradigm)

The pull paradigm enables the user to select exactly the content that he/she wants to listen and to listen to at any moment. Stored content on recordable media (CD, DVD), flash Medias or hard drives (MP3 players, cell-phones, etc) have the advantage to be available even when no wireless communication is reachable. The drawback is that the audio content available on them is limited to the storage capacity of these media which has consequences in term of diversity and it cannot be updated without synchronization. But above all, the new breakthroughs in terms of available data rates among wireless connections such as UMTS, Wifi or Wimax make more ubiquitous the online music catalogues (Amazon, iTunes, Rhapsody, etc) and audio podcasts. In our architecture, our client is able to access various online music libraries and also to update podcasts. Description metadata coming along with this type of content is the largest and the most accurate. Online music catalogue tag their music items with ID3 tags or equivalent in order to index them more easily. Podcasts are described using a standardized XML syntax. In case of dealing with untagged stored music like CDs, services like Gracenote or MusicBrainz , can overcome the lack of metadata with a fingerprint recognition technology.

4 Describing the driving context

4.1 Available network resources in the vehicle

In this scenario, we will assume that the capacities of the terminal are not changing and are independent from the vehicle (the same software is installed on the same hardware in all the vehicles using our platform delivery service). As a result our delivery platform will not take in consideration, any adaptation of the content to the nature of the client (transcoding, transmoding, etc) which would be beyond the scope of this publication. However, we still take into account the versatile nature of the wide-band connection, i.e. the client can automatically switch to an FM radio when no more online connection is available or when the rendering of a live-content is requested, and when no FM radio is properly available switch to AM radio or to a local content resource. MPEG-21 framework is well suited to describe the context.

4.2 Driving conditions

Driving conditions refer to the environment from a user-centric point-of-view. MPEG-21 provides also descriptors for the geolocation, time, audio environment

Type of source	**Persona-lization**	**Available Metadata Content**	**diversity/update**	**Coverage and availability**
Analog Radio Broad-cast	None.	Limited to RDS and RD+ standards for FM.	Large choice of radios. Up to date live news available.	Large.
Digital Radio Broad-cast	None.	Description of the broadcasted programs.	Large choice of radios. Up to date live news available.	Limited areas depending on the technology used.
Stored Media	On demand, possibility to rate content.	ID3 tags (title, artist, genre)	Not up-to-date, diversity depending on the amount of stored data.	Independent of coverage.
Online Infotain-ment (On-Demand cata-logues, Podcast services)	On demand, possibility to rate content and see other people ratings.	Very large. ID3 tags included in downloaded MP3s. XML description of podcasts using Atom or RSS.	Very large choice of content. Last album released available. Live streaming and up-to-date podcasts.	Wifi, Wimax, limited to urban regions. UMTS still unavailable in remote regions.

Table 1: Comparison of the different types of infotainment sources available and their possibilities in term of mobility and collaborative adaptation

and illumination characteristics. Unfortunately, it does not provide descriptors using traffic condition or weather driving conditions that are really influencing the driving experience. Nevertheless, based on geolocation and time description, the system can easily retrieve traffic and weather information from online services or infotraffic sources. This information can thus be stored using explicit semantic specification [Tsinaraki and Christodoulakis 2006].

5 Defining and creating user profiles for a personalized experience

The creation of user profiles can come from various sources. The easiest solution is a web portal where the user fills in some fields concerning his music tastes.

But there is very little chance that users may want to spend a lot of time in defining his music tastes. Moreover, his tastes may change in time and need being updated. In terms of music personalization, an incredible amount of internet services are now available online such as Imeem , Last.FM or Rhapsody . Not only do they allow creating easily a user profile, by selecting artists or music tracks as favorites, but some of them also update their user's profiles by monitoring user behaviors or saving relevance feedback. Actually, user profiles are not static data at all and need being updated. The description of an audio-user profile for a driving entertainment experience should contain the following information:

– Music preferences: The music preference should identify what the user likes to hear when driving. The simplest way is to record ratings of each song, the personalisation system can then choose the songs that the user likes at best. Same approach can be done by artist or by genre so as to broaden the amount of music items that are rated.

– Non-musical infotainment preferences: Non-musical infotainment refers to an editorially-defined program like a news edition from a commercial radio. The user may want to precise if he wants to hear the last edition of the news (i.e. exactly on time when it is being broadcasted, it could be the case for football match results for instance), if need be, the client has to switch to a push service paradigm, otherwise the client can download the latest podcast of the program and render it.

Preferences concerning musical as well as non musical infotainment are not only user dependent but rather user context dependant. As previously mentioned, we are dealing here with an audio-driving profile but the definition of an ontology describing the different context of driving is necessary to refine the adaptation policy. For instance, the user may have different preferences depending if he is driving by night or during the day. FOAF provides a basic way to describe preference using the interest descriptor [Oscar et al. 2005]. The interest of FOAF is that it can enable to bind different preference profiles from different users. A differentiation between the sort of knowledge between theses users is semantically possible (colleagues, friends, etc). MPEG-7 Description Schemes provides a much more detailed way to describe the user preferences themselves via its `Filtering-AndSearchPreferences`, `Preference-Conditions`, `ClassificationPreferen-ces`, `SourcePreferences` descriptors. The combination with various description schemes like (genres or artist) and MPEG-21 environment description enables very refined description of preferences depending on context.

6 A user-centric architecture for flexible context adaptation

In this section, we present an architecture which is able to handle the integration of preference profiles in terms of infotainment. Our architecture core functionali-

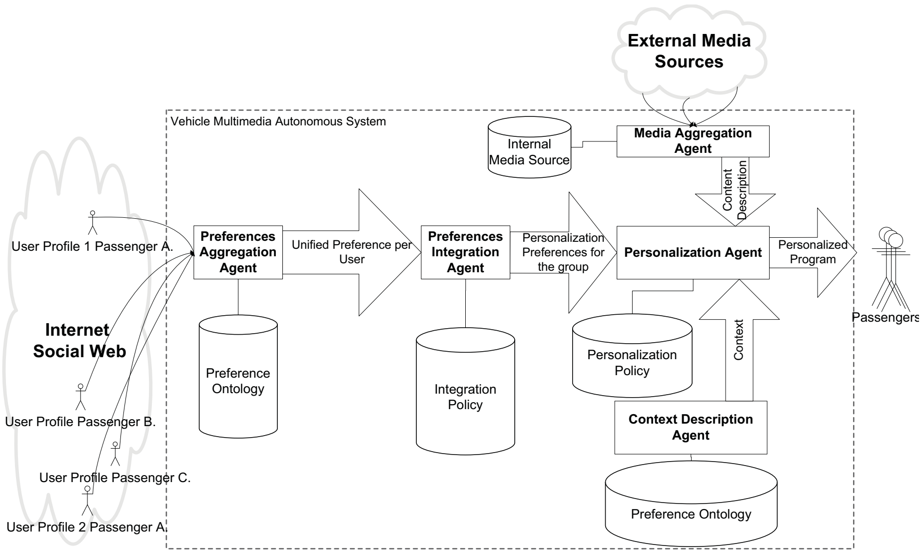

Figure 1: Architecture for multimedia preferences adaptation to the context

ties are the creation of personalization policies based on the user preferences and adaptation policies, and the delivery of a personalized service based on the previously created personalization policy and a knowledge of available content. The architecture makes use of the available metadata for the various infotainment sources from analog broadcast to on-demand online infotainment services.

A profile aggregator is a functional component that can retrieves personal profiles coming from various sources. A single user can have different profiles on different online services. Thus a mechanism to discover and resolve these different profiles is necessary if we want to aggregate them. OpenID, [Recordon and Reed 2006] is an example of a universal way to address and discover different services with a single identity. As previously said, those profiles can come from various sources and have to be integrated, meaning that the aggregator can understand the different standards used by the different services and process them with its own ontology before they are merged into a group profile.

A preference integrator is a functional component that combines them to create a common infotainment personalization profile. The preference integrator must have its own integration policy, for instance it may decides to give more importance to the preference of the driver of the vehicle. Several approaches for making decision that pleases everyone have been proposed, [O'Connor et al. 2001] and [Chao et al. 2005]. The role of the integration policy is to describe which approach has to be processed by the system. The context description agent is a functional component that can describe the driving context. It combines the output of local sensors like the noise level and the luminosity, with content provided by GPS position or traffic information.

Contextual updates are regularly sent to the personalization agent which is a functional component that matches the personalization profile with the context description and available content to provide a personalized infotainment service. The personalization policy describes which approach has to be used to display adapted content. A basic approach could be to take the highest ratings and display content items corresponding to these ratings. However a limitation is that only the items which have been rated can be proposed. Recommendation models based on music similarity [Selfridge 1995] or latent semantic indexing [Hofmann 2004] make possible the creation of playlists which includes musical items which have not been rated but that the user may like. Another limitation of rating music by genre is that it is a very music-centric approach and thus is limited to the nature of the genre taxonomy used, [Pachet 2000]. A more user-centric approach has also been proposed to overcome this problem, [Lesaffre et al. 2003].

7 Illustration of the architecture with the scenario

Step 1: *Each of our three travel friends has a profile containing preferences and this profile is accessible online. In their preferences they specify the type of content they like to listen when driving.* In this step, online services are used to describe the user preferences. The user profile has to be available online in order to be retrieved by the content aggregator. The profile integrator compares these aggregated profiles and uses its integration policy to combine them. The integration policy chooses to give priority to the driver of the car (Andreas) and to render classical music even if Christopher hates it.

Step 2: *Andreas, Barbara and Christopher start driving. During their journey they have to cross various regions from urban environments to mountains and the availability and the quality of wireless service is changing.* When they start driving from their home city, the multimedia system can reach easily broadband wireless access. Podcast download and music libraries are used to propose to the user a content matching as much as possible their preferences. When they get away from the city and enter a mountainous environment, the personalization agent is informed by the context description agents of the loss of the online connection. The multimedia system switch seamlessly to local content available or to analogue radios if available.

Step 4: *When leaving each other, our three road mates want to keep track of their infotainment experience as a group. They may want to bind their profiles and to mark their common interest in order to refine the personalization of their future journeys together.* If available online FOAF files of the users are updated to bind their profile. Thus, the profile aggregator can more easily locate and resolve their preferences in the future.

8 Conclusions

After identifying the different sources of metadata information necessary for a proper personalization of the content to a small group of users, we described an architecture that uses semantic descriptions of actors and resources to provide a personalized infotainment experience. Our architecture, involves both multimedia descriptions of the infotainment content assets and semantic description of the users. The combination of both information sources at different steps can be done using different strategies that have to be specified in the corresponding policies. Our scenario illustrates how our architecture can support both a service adaptation logic depending of the environment and a personalization logic adapted to the users.

9 Future Work

We will concentrate in the future on the different possible approaches that can be defined in the integration policies of user profiles. The problem of updating and refining the personalization system (based mainly on recommendation algorithms), by monitoring the users behaviour as a group will also be addressed.

References

[Chao et al. 2005] D. L. Chao, J. Balthrop, and S. Forrest. “Adaptive radio: achieving consensus using negative preferences”. Proc. ACM SIGGROUP, 2005.

[Hofmann 2004] T. Hofmann. “Latent semantic models for collaborative filtering”. ACM Trans. Inf. Syst., 22(1):89-115, 2004.

[Lesaffre et al. 2003] M. Lesaffre, M. Leman, K. Tanghe, B. De Baet, H. De Meyer, and J.-P. Martens. “User-dependent taxonomy of musical features as a conceptual framework for musical audio-mining technology”. Proc. Stockholm Music Acoustics Conference, 2003.

[O’Connor et al. 2001] M. O’Connor, D. Cosley, J. A. Konstan and J. Riedl. “Polylens: a recommender system for groups of users”; Proc. ECSCW’01, Norwell, MA, USA, 2001.

[Oscar et al. 2005] C. Oscar, R.Miquel, and P. Herrera. “Foafing the music: a music recommendation system based on rss feeds and user preferences”. 2005.

[Pachet 2000] F. Pachet. “A taxonomy of musical genres”. In RIAO, April 2000.

[RDSForum 2005] RDSForum. Radiotext plus (rtplus) specification, 2005.

[Selfridge 1995] E. Selfridge-Field. “In melodic similarity - concepts, procedures, and applications”. 1998.

[Tsinaraki and Christodoulakis 2006] C. Tsinaraki and S. Christodoulakis. “A multimedia user preference model that supports semantics and its application to mpeg 7/21”; Multi-Media Modelling Conference Proceedings, pages 8 pp.-, 2006.