MPEG-7 MDS-BASED APPLICATION SPECIFIC METADATA MODEL FOR PERSONALIZED MULTI-SERVICE ACCESS IN A DTV BROADCAST ENVIRONMENT

S. Tsekeridou

Democritus University of Thrace
Electrical & Computer Engineering Department
67100 Xanthi, Greece
Telephone: +30 25410 79586, Fax: +30 25410 79569
Email: tsekerid@ee.duth.gr

ABSTRACT

The paper presents an MPEG-7 Multimedia Description Schemes (MDS)-based metadata and user profile model used within an enhanced DTV environment for semantic annotation and personalized access to multiple sports DTV services. It is shown that in order to enable intelligent and personalized processing, management and use of multimedia content and services, the use of application specific metadata descriptions and adequately formulated user profiles is most important. Thus, application specific semantic metadata and user profile definitions are presented in this paper. Metadata and user profile instances are generated by Authoring/Annotation tools or User Profile Registration client applications respectively. Personalized access to sports DTV services is achieved by metadata and user profile instance description matching and content filtering at either the server or the client side. At the same time, dynamic client configuration, transparent to the end-user, is accomplished by automatically processing configuration specific metadata descriptions using specially designed application modules at the client side. The main purpose is to enable personalized integrated multimedia services access in the sports domain over DTV infrastructures.

1. INTRODUCTION

The significant research efforts and the advent, in our everyday life, of advanced technologies for capturing, management, storage, transmission and use of multimedia content has led to a keen interest of major business actors in enabling next generation multimedia services. To allow for intelligence and automation in the manipulation of content and services throughout their entire lifecycle, metadata descriptions are crucial [1]. This is also justified by the extensive work performed within standardisation bodies to define appropriate metadata descriptions, such as the MPEG-7 standard [2, 3, 4] defined to allow for audio-visual content generic descriptions, both low-level and high-level (semantic) ones, or the TV Anytime Forum standards [5]. Metadata description models as well as metadata repositories should be easily extended to accommodate the real needs of emerging applications. Such an approach has been reported in [6] aiming at the provision of scalable broadcast and internet content and services to a variety of platforms. The main difference of the proposed approach is its focus on application domain (that of DTV sports broadcasts) specific metadata extensions of the MPEG-7 MDS part for the semantic and functional description of associated and simultaneously transmitted content streams and associated integrated services (e.g. MPEG-2, MPEG-4 and MPEG-7 streams, DTV broadcasts along with e-commerce services, such as betting or advertising and electronic sales).

This paper presents an MPEG-7 MDS-based metadata and user profile model used within an enhanced DTV environment for semantic annotation and personalized access to multiple integrated sports DTV services. Authoring/Annotation tools as well as User Profile Registration client applications are used to generate application specific metadata and user profile instances. Personalized access to enhanced DTV services is achieved by metadata and user profile instance description matching and content filtering at the client side. At the same time, dynamic client configuration, transparent to the end-user, is accomplished by automatically processing configuration specific metadata descriptions using specially designed application modules at the client side.

The metadata and user profile model is application specific, aimed for enhanced DTV sports-based services provisioning and access, and, although based on the MPEG-7 standard, its extensions can only be used within the specific system. However, it clearly illustrates application specific MPEG-7 usage and extensions that could contribute to standardised application specific extensions to MPEG-7 or serve as basis for dedicated extensions to MPEG-21 DIA definitions and tools. An example of the former approach is presented in [7] defining an MPEG-7 metadata scheme for Video-based GIS Applications.

To make the reader better comprehend the specific application requirements in metadata descriptions, the end-to-end multi-service system for enhanced and interactive digital TV sports broadcasting, associated service provisioning and personalized access is briefly presented in Section 2. The involved processes and design issues are briefly analyzed to lead to requirements on metadata descriptions, and thus to the application specific MPEG-7 MDS based metadata definitions, presented in Section 3. Section 4 outlines our conclusions.

2. ENHANCED AND INTERACTIVE DTV SPORTS MULTI-SERVICE SYSTEM

The addressed enhanced and interactive DTV sports multi-service system focuses on the DTV coverage of sports events, enabling at the same time supplementary, sometimes subscription-based, services alongside conventional sports TV programs, such as enhanced and interactive content, betting, personalized advertising. More details about the end-to-end systems may be found in [8, 9].

Users equipped with an appropriately-designed terminal are able to access enhanced content and services and easily interact with multimedia objects to obtain further rich-media descriptive information of their interest, or trigger a service option, e.g. bet placement, or advertisement display, and customize the way in which they watch the events by being able to register their preferences. The term *enhanced content* defines supplementary textual/audio/visual information about the actual broadcasted content, transmitted alongside the latter, that offers the user enhanced and alternative ways of consumption and entertainment. It can be thought of as a novel way of information visualization and access, which accompanies the broadcasted content.

The system is composed of two ends, the DTV multi-service creation end and the client end. The design of such a multimedia system at the multi-service creation end involves the processes shown in Figure 1. In addition, the design processes at the client
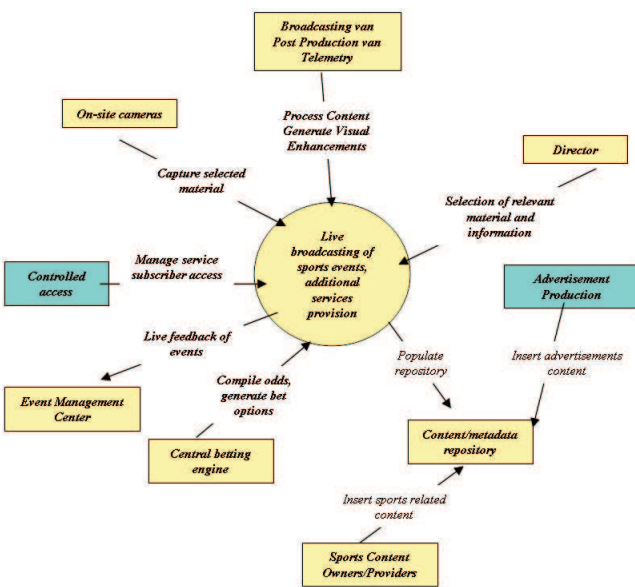

Fig. 1. Involved processes at the server end.

end are shown in Figure 2. In order for the reader to better comprehend the addressed application, we describe a sample application scenario: a Formula 1 fan uses his handheld computer to watch an enhanced Formula 1 race. He is able to constantly view a virtual track and the classification results, receive updated statistics information, in-play bet options, or advertisement content displayed to him or not based on his pre-registered preferences, and is able to trigger e-commerce transactions by interacting with received advertising content. All these functionalities are enabled through the implementation of the system design processes presented above.

2.1. Why use metadata?

The main requirements satisfied by mainly semantic metadata descriptions within the addressed application framework, to make it much more efficient, automated, intelligent and user-friendly, are:

- Allow for a **unified, application-specific description of any type of sports content, as well as related enhanced content and services, along with their associated semantics**.
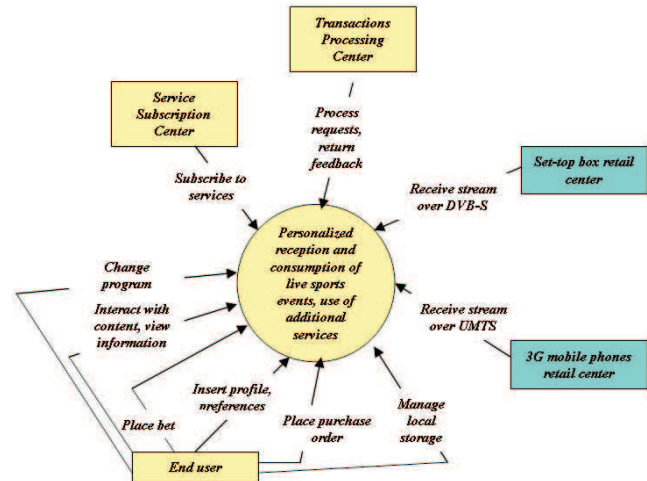

Fig. 2. Involved processes at the client end.

- **Combine a multitude of information sources for a complete representation of the stored and transmitted data**. Hence the defined metadata ontology combines information about sports (e.g. rules), athletes (e.g. ranking in the world, recent accomplishments, records, other CV data etc.), events (history, importance for international ranking, records, sponsors etc.), event venues (e.g. stadium capacity, current amount of viewers etc.), broadcaster information (amount of cameras owned, mobile crews available etc.), event coverage (positioning of cameras within the stadium, capabilities of each camera etc.), service related information (e.g. types of supplementary services, types of bets, advertisements, transaction related information, etc.) as well as functional information related with the produced interactive content and its handling.

- Allow for **efficient filtering mechanisms** and personalization based on the comparison of incoming metadata and preregistered user profiles stored at the terminal.

- Describe **user profiles and group of user profiles**, that encapsulate user preferences with respect to sports, events, types of enhanced content and services offered.

- Further allow for **easy retrieval and accessing of received and stored for later view enhanced content at the terminal**. This requirement comes to meet the further requirement of efficient local storage management at the terminal.

- Supply **descriptive textual information** with the aim to visually present it to the user upon his request (interaction mode) about the received sports event, athlete, statistics, promotion, bet option etc.

- **Supply information and control the functional behavior** of the various invoked per case APIs of the terminal (e.g. management of the MPEG-4 player menu options and interaction modes).

3. MPEG-7 BASED APPLICATION SPECIFIC METADATA AND USER PROFILE DEFINITIONS

It is generally accepted that metadata descriptions, based on standards or not, are greatly dependent on the application or service

they are aimed for. To account for application specific requirements, although potentially jeopardizing interoperability for open systems, appropriate combination of metadata standardised and individually introduced non-standardised descriptions should be considered. Thus, in order to satisfy the requirements for metadata descriptions within the above system, a sports dedicated metadata schema has been defined to describe, among other potentials, sports broadcasts and enhanced interactive content and associated services, mainly with respect to their semantics. The metadata model is represented in XML Schema and based on already defined description schemes within the MPEG-7 MDS[3].

An important aspect that differentiates the presented metadata model from other similar attempts (even in the sports domain, such as SportsML), is that it combines the application domain information with broadcasting, workflow control, sport event data and additional service related information into a more extended ontology, that takes into account the additional requirements in content description introduced by parallel content streams transmission (such as enhanced interactive content mainly coded in MPEG4). The presented model exhibits an MPEG-7 sample use case in the DTV sports broadcasting domain.

In detail, the broadcasters create a schedule (e.g. the event name, location, and the participating athletes' or teams' names and CVs, the sponsors, the supplementary service related event triggers), according to which the capturing and creation of visual enhancements as well as service enabled elements will be produced. The broadcasters use specially designed Scheduling and Authoring/Annotation Tools to generate schedule information and manually insert semantic descriptions about the event or the associated services. These tools lead to automatic generation of metadatata description instances, as shown in Figure 3, stored in a RDBMS repository. The metadata instantiations, during the pro-
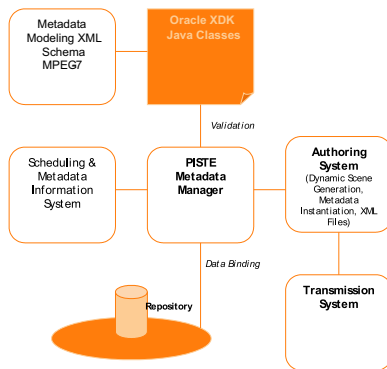

Fig. 3. Architectural design of the multi-service creation metadata management modules.

duction stage, retrieve semantic information stored in the production multimedia and metadata repository as well as use dynamic information, available only during the live coverage of the event. The complex type definition that encapsulates all introduced domain specific metadata extensions is shown in Figure 4. It extends MPEG7BaseType and is defined as the instance type of a DescriptionUnit child element of the Mpeg7 root element in MPEG7 xml instance files. This is done since these metadata descriptions do not present a complete description of the transmitted media. The child elements of the new complex type are Description Schemes extending MPEG-7 MDS DSs: ViewersProfile (that

describes a group of viewers and their aggregated preferences), ViewerProfile (that describes a viewer and his/her preferences, extending the MPEG7 UserDescriptionType), SportEvent (that contains all semantic information about the covered and broadcasted event, location, participating teams/athletes, schedule, sponsors, event phases and enabled per time period services, etc., extending the MPEG7 EventType) and InteractiveContent (that describes descriptive and functional information related with the produced interactive MPEG-4 content stream, accompanying MPEG-2 transmitted streams). The metadata instances are processed at the viewer
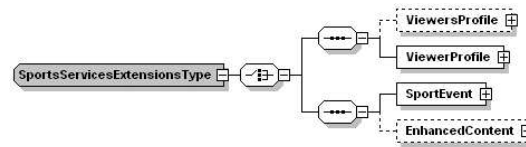

Fig. 4. The proposed complex type of the metadata schema, a wrapper of all possible metadata element definitions relevant to the addressed application.

terminal and compared against the viewer preference information to allow for personalized presentation or handling of enhanced sports content and services. Such preferences may be his/her favourite national team or sport event or the types of enabled services (e.g. receive bet options or advertisement content for lower subscription rates). Viewer or group of viewer preferences definitions are finally matched together with related metadata instances, weighted based on the preferenceValue attribute value of each preference, and combined together to produce the final decision on whether received content, information and services are of the viewer's or group's interest. In the previous and all subsequent definitions,
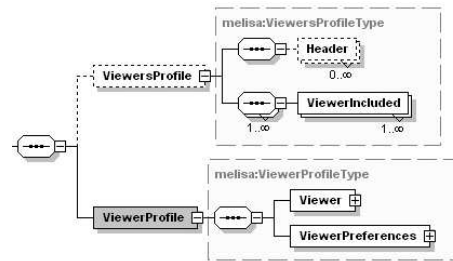

Fig. 5. Definition of the ViewerProfile and ViewersProfile elements.

the mpeg7 namespace is associated with MPEG7 MDS descriptions (such as Mpeg7Type or CompleteDescriptionType in the above).

Figure 6 presents the SportEvent element definition, one of the main child elements of the root element, that contains all semantic information about the sport event, mainly known before the event (except for dynamic or live data, such as event phases). Such information may be the location and time of occurrence, the participating teams or athletes (accomplishments, records, CVs, etc.), the sponsors of the event, the broadcaster that covers the event, information about the type of sport (rules, world records, etc.), mainly known beforehand, but also the phases that have occurred or are currently occurring (foul, penalty, etc.), the types of enhancements produced during these phases, the involved athletes

or teams, statistics data, or service related dynamic information such as in-play bet types at the current instance, ads content and transaction related information, etc.
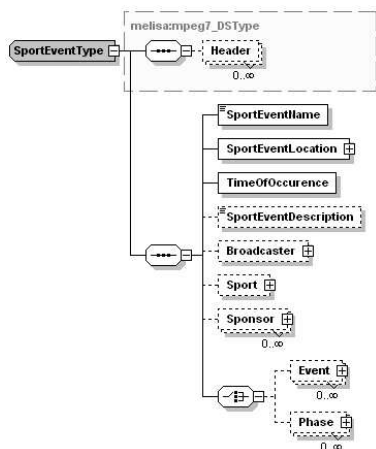

Fig. 6. Definition of the SportEvent child element.

Finally, Figure 7 shows the definition of the EnhancedContent element definition (in our case the format of such content streams is MPEG-4 graphics profiles) which mainly contains service related and functional information necessary to the user terminal automatic configuration, as well as references to all types of enhanced content and services that the received content carries - this aids in faster filtering and personalization, as well as in efficient enhanced program list creation - conventional program listing is automatically generated by the MPEG2 PTS/MPEG4 BIFS descriptions. Functional information may be the color used for defining transparency, or the spatial resolution of the visual enhancements or even the number and types of defined interaction nodes. Such functional information is automatically used by client application modules to dynamically configure the client behaviour and content presentation. The final produced content may include a variety of enhanced content items such as visual enhancements (referenced by the EnhancementsList child element), list of bet options (referenced by the BetsList child element), list of ads and e-commerce content (referenced by the AdsSponsorsList child element).
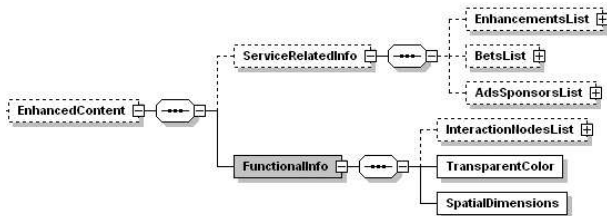

Fig. 7. Definition of the EnhancedContent child element.

Although the above metadata definitions are not all the MPEG7 MDS based introduced extensions of the presented metadata model, they give a rather satisfactory overview of the entire metadata modeling concepts. Figure 8 shows a sample screen shot of a broadcaster's online tool that links to the metadata generator component and produces the metadata instances to be transmitted. A sample

metadata instance of the an earlier version of the presented model is also illustrated.
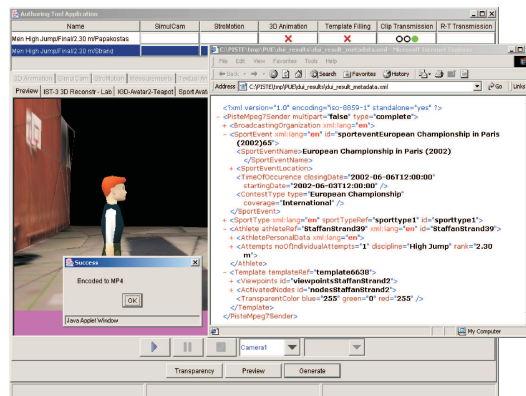

Fig. 8. An example of metadata instantiation.

4. CONCLUSIONS

This paper presents an application specific MPEG-7 MDS metadata and user profile model to account for the real needs of an enhanced DTV sports content production, transmission and consumption application. Metadata descriptions are proved crucial in enabling personalized access to services, semantic annotation of sports events and associated services, efficient client local storage management as well as dynamic configuration to received content. Metadata descriptions are associated with new content types and services and thus allow for the introduction of an intelligence layer within the system, that operates mainly on the semantic and functional level.

5. REFERENCES

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