MPEG-21 IN BROADCASTING

role in the digital transition of broadcasting

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Abstract: The transition to digital in the TV broadcasting industry is already gradually being performed while the complete digital switchover seems now possible to be accomplished within the near future. This article describes and analyses this phenomenon and the role of MPEG-21 may play in it. MPEG-21 is the ISO/IEC standard currently under development in MPEG (ISO/IEC JTC1/SC29/WG11). Unlike preceding MPEG standards - MPEG-21 does not specify a coding format of the content but rather a set of standards to ease transactions of multimedia content and the provision of digital multimedia services in heterogeneous network environments, including broadcast. In this paper, we highlight the role of MPEG-21 in broadcasting, in particular in the deployment of digital TV services.

1 INTRODUCTION

The use of digital technology in TV broadcasting enables the provision of increased quality and functionality and will have a major impact on the viewing behaviour of consumers. We will describe those major changes and analyze potential problems and potential usages of MPEG-21 to help

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broadcasting industry to relax such problems.

MPEG-21 specifies a set of standards to ease transactions of multimedia content and the provision of digital multimedia services in heterogeneous network environments, including broadcast. MPEG-21 is being designed as a common standard for range of applications of digital multimedia content and one of most important applications is digital broadcasting. Various aspects in digital broadcasting including networking, events, channels, services, programs, signalling, encoding, bandwidth, conditional access, subscription, advertisements and interactivity, are all covered by MPEG-21, placing it therefore in a position to framework to be applied in digital broadcasting.

2 DIGITAL TRANSITION IN BROADCASTING

2.1 Transition in performance and platform

Currently there is a clear trend in the market towards wider range of receiver platforms including mobile platform and higher definition platform. The sales of personal digital recording are growing very quickly. This all lead to the rapid replacement of the basic tool of subscribing broadcasting service.

2.2 Transition in functionality

Change of platform and performance introduces several new functionalities. Most widely appreciated function is time-shifting by personal recording devices. The combination of electronic program and personal recording derives great enhancement of viewing opportunity. Networking functionality is not very widely used currently, but it might have great impact if broader bandwidth capable to handle video will be widely available. For the audio broadcasting, internet is powerful enough to deliver audio broadcasting and there are over 1000 internet audio broadcasting station is US and Europe.

2.3 Transition in viewing behaviour

Interactivity can be provided to the TV viewer in many different ways. There are two main categories of iTV programming, unrelated or related to the scheduled programming. The first is referred to as “24/7” as it comprises interactive services available all the time. The second, “enhanced services” includes the provision of alternative camera angles or feeds during live events, possibility to vote on contestants in a show or playing with them, but also additional information related with the normal programming. These services whilst imposing new challenges to the TV broadcaster, are already part of their new business model and are changing the way viewers behave in front of the TV set. This is being seen as a personal device, able to satisfy in different ways their needs, providing them control to decide the timing and detail to which they watch TV.

3 CHALLANGES FOR MPEG-21 IN BROADCASTING

3.1 Potential problem

The new digital era in TV broadcasting brought the multi-channel technology, a considerably larger number of competing channels combining huge quantity of archived and new material. TV broadcasters are seeing themselves confronted with new challenges and hard competition. In order to be successful and maintain the loyalty of their audience or even increase it, broadcasters need to provide more quality, to offer more choices, to provide different “flavours” of the same content, to delivery news fast, to re-distribute content in a differentiated way, all this across multiple platforms. And in order to be competitive, they need to do it efficiently without incurring excessive extra costs.

3.2 Role of MPEG-21

The current workflow in the broadcasting chain is not adequate to allow re-purposing or re-packaging the content to support cross-media delivery and audience-adapted programming. The process is complicated as it involves many people with different backgrounds, roles and rights as well as a large amount of content and metadata coming from different sources and in different formats. All this information must be easily accessible to all and its consistency guaranteed throughout the complete broadcast workflow. This is where MPEG-21 comes into play.

4 MPEG-21 OVERVIEW

MPEG-21 is the ISO/IEC standard currently under development in MPEG (Burnett et al., 2003) (Bormans, Gelissen and Perkis, 2003). Unlike preceding MPEG standards, MPEG-21 does not

focus on the specification of audio-visual compression formats, but rather on a set of descriptions to ease transactions of multimedia content in heterogeneous network environments, including broadcasting. The standard is currently divided in 16 parts, from which the ones listed in Table 1 are considered by the authors as the most relevant for the work presented in this article.

Table 1: The first seven parts in MPEG-21

Part	Title
1	Vision, Technologies and Strategy
2	Digital Item Declaration (DID)
3	Digital Item Identification (DII)
4	Intellectual Property Management and Protection (IPMP)
5	Rights Expression Language (REL)
6	Rights Data Dictionary (RDD)
7	Digital Item Adaptation (DIA)

The basic concepts of MPEG-21 are the **User** and the **Digital Item (DI)**. The User is any type of content manipulator (e.g. subscriber, producer, provider, network). The DI corresponds to a combination of multimedia resources (e.g. MPEG-2 Audio and Video bitstreams) with associated metadata (e.g. Rights descriptions and/or MPEG-7 Audio and Video descriptors). MPEG-21 builds its functionality on top of the Digital Item Declaration (DID, part 2 of the standard), which consists of a basic model expressed in XML defining the structure and organisation of DIs. The model constitutes the foundation to provide higher-level functionality, enabling identification, description, handling, monitoring, adaptation and universal usage of the DI. MPEG-21 tools envisage the provision of multimedia content and services satisfying the users' needs and rights in the best possible way given network, terminal and environment constraints and in a secure and seamless way. This scope translates into the well-known concept UMA, the Universal Multimedia Access. UMA addresses the delivery of multimedia resources under different and varying network conditions, diverse terminal equipment capabilities and user or creator preferences and needs, while enforcing IPRs and usage rights The parts of the standard included in Table 1 are the fundamental vehicles for the effective implementation of this concept. Digital Rights Management (DRM) are addressed in parts 4, 5 and 6 - specification of a rights expression language (part 6 – REL), its corresponding dictionary (part 5 – RDD) and a DRM architecture allowing interoperability between the different parts of MPEG-21 and between different DRM systems (part 4 – IPMP). Eight different DI Adaptation tools are specified in part 7, each comprising a description and a resource adaptation engine. These are applied to the DI in order to seamlessly produce the Adapted DI to heterogeneous networks and environments, terminal's constraints or user preferences (Pereira and Burnett, 2003) (Perkis et al., 2002) (Fossbakk et al.,2001). DI Adaptation operations may modify binary resources or metadata of the input DI or the declaration of the DI to the usage environment.

5 USE OF MPEG-21 IN BROADCASTING

MPEG committee acknowledges broadcasting as one of the most important application of digital multimedia. Usage scenarios of MPEG-21 in broadcasting are currently under heavy investigation incorporated by special ad-hoc group established by MPEG, named "Ad-hoc group on MPEG-21 in broadcasting". The authors of this paper are actively participating in this activity. This section describes several of the usage scenarios currently under investigation.

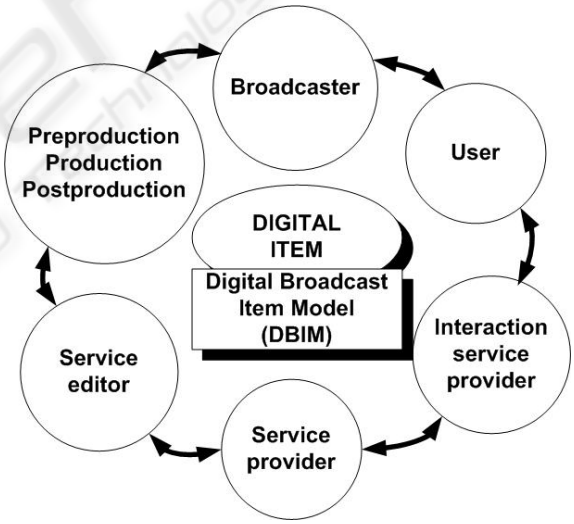

Figure 1: Digital, Interactive TV value chain

5.1 Digital broadcast item model (DBIM)

The DBIM represents the model of digital content for broadcast use (Figure 1). A typical digital TV value chain consists of many phases such as preproduction, production, postproduction and delivery. The goal is the introduction of a digital item for broadcasting use – a Digital Broadcast Item

(DBI). Each MPEG-21 based DI has an underlying model describing the behaviour and characteristics of the item in context. The DBI underlying model is especially designed for the broadcasting context. This model is named *Digital Broadcast Item Model (DBIM)* (see (Lugmayr et al., 2004)).

The purpose of the DBIM is the harmonization of several metadata standards as utilized in broadcasting towards a unified life-cycle and workflow model. MPEG-21 shall be utilized as umbrella standard. The DBIM is based on an MPEG-21 DI especially used in broadcast context throughout the broadcast value-chain. A DI is used to communicate between several partners in the value-chain.

5.2 Interoperable AV clips in broadcasting

Due to the rapid growth of personal digital recording and the phenomenon of technology convergence, interoperable audiovisual clips are being regarded as one of the most important usage scenarios in broadcasting. While such clips must be playable on any existent audiovisual device and medium, the full exploitation of the service imposes that the rights of the content owners are adequately managed using the existing content protection technology. Concerning increasing new phenomenon in digital transition, there are also increasing interest for advanced security models e.g. Multi-Lateral Security (Kaneko and Shirai 2001) and scalable architecture. In this context the common representation formats and the tools to adapt content defined in MPEG-21 parts 4, 5 and 7, may play an essential role and provide ground for real interoperability among different DRM technologies. MPEG has been undertaking great efforts for the standardization of IPMP mechanisms since 1996, having already completed the MPEG-2 and MPEG-4 IPMP specifications. Current work includes the refinement of requirements for MPEG-21 IPMP and evaluation of proposals towards the final phase of standardization. But even if MPEG-21 IPMP is in its early stages, a closer look at how IPMP works in an MPEG-4 terminal can be of great help for the purpose of this paper.

Figure 2 shows a conceptual block diagram of an MPEG-4 terminal with IPMP Extensions. The content (left in the figure) contains a data structure referred to as IPMP Tool List and IPMP Information, which includes IPMP Tool IDs and Locations. This information allows terminals to identify and collect the required IPMP tools that control the access to the content. Once activated, together with the terminal elements implementing the IPMP messaging interfaces, the access to the content is unlocked.

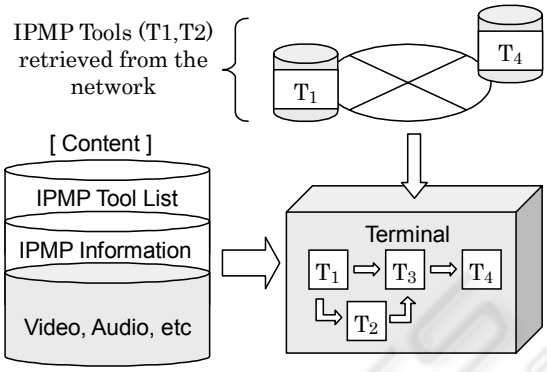

Figure 2: MPEG-4/IPMP architecture

5.3 Quality of service management

The management of *QoS (Quality of Service)* throughout the broadcasting chain, from content production to end-user consumption is a real issue in the broadcasting world. The goal is to achieve the best possible QoS for the end users taking into account their expectations as well as the technical capabilities of the terminal and the resources and technical parameters of the delivery networks. The main benefit is the provision of end-to-end control of the QoS delivered to the end user.

As a specific usage scenario, an end user receives multimedia content through a broadcasting infrastructure with some guaranteed QoS. The user may have different types of terminals (Set-Top-Box, PC, mobile phone, video-game consoles…) and access over heterogeneous networks, for example with multi-channel distribution (DVB-T, DVB-S, DVB-H, UMTS…).

Several description tools provided by MPEG-21 DIA are useful for this purpose. As example `AdaptationQoS` description tools are designed for the adaptation of the audio and video bitstreams to match the network constraints, especially bandwidth. `Terminal Capabilities` are description tools designed for the adaptation of the multimedia content to fit the exact characteristics of the consuming end-user terminal. Such characteristics could be the number of speakers, screen size, etc. Other useful descriptors are the `Network characteristics` which are specified in terms of network capabilities and conditions, including available bandwidth, delay and error characteristics.

5.4 Metadata filtering

Manifold data is present throughout the broadcast value chain and has manifold representation formats. The relevant data should be preserved and extracted semi-automatically for commonly known digital TV services. Examples are the digital TV program guide; news broadcast show; informational services or weather forecasts.

Multi-channel application, thus information to be published through different information channels relies on the re-use and transformation of existing data sources (e.g. teletext content is in parallel published on a web-page).

The key to realize metadata filtering is the re-use of metadata, template libraries for services and computer assisted editing are some examples for how the process can be made easier. The goal of the ad-hoc group is to introduce metadata filtering as basic concept to integrate metadata across systems (see Figure 3).

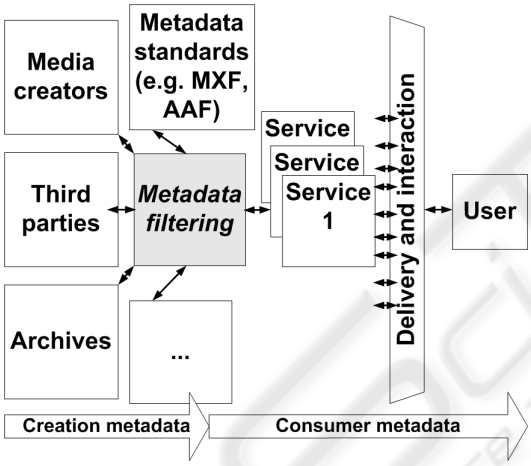

Figure 3: Metadata filtering

A very specific example in broadcasting is the management of service information. Service information describes the content of television programs. In principle service information is the basis for an electronic TV program guide, commonly known as Electronic Program Guide (EPG). Service information is organized in many different tables. The data for these tables needs to be manually edited, maintained, re-edited and extracted from multiple sources. This implies a simpler solution to automatically obtain basic information for the EPG and prepare it for play-out. Metadata eXchange Forrmat (MXF) and Advanced Authoring Format (AAF) files are one potential source for the basic EPG information. Metadata filtering addresses the catalysis of metadata from different sources. It also includes the preparation of metadata for play-out. The term catalysis addresses several metadata processes, such as metadata transformation, conversion of metadata, building the content of metadata files (e.g. through segmentation, data mining), validation or visualization.

We can distinguish between creation metadata and consumer metadata. Creation metadata is metadata typically used in professional broadcast systems. Examples are MXF, AAF and the P/Meta initiative. Consumer metadata convolves several data structures delivered to consumer networks for further use. Examples are service information making up the basic information for the Electronic Program Guide (EPG), TV-Anytime descriptions and especially MPEG-21 metadata.

6 CONCLUSIONS

Within the scope of this paper we were able to present a brief description of the MPEG-21 standard and its potential applications in broadcasting. A few important usage scenarios have been described to illustrate such applications.

Currently, many standardization activities aim at the convergence of various multimedia services including the broadcasting environment (Table 2). Among those activities, MPEG may be obligated in the harmonization of MPEG application in media convergence.

Table 2: Standardization activity in media convergence

Organization and activity	URL
TV-Anytime Forum	http://www.tv-anytime.org/
Pro-MPEG:Material eXchange Format (MXF)	http://www.mxf.org/
SMPTE: SMPTE 360M General eXchange Format (GXF)	http://www.smpte.org/smpte_store/standards/
SMPTE: SMPTE 335M Metadata Dictionary	http://www.smpte.org/smpte_store/standards/
Pro-MPEG: Advanced Authoring Format (AAF)	http://www.aafassociation.org/
EBU:P/META (Metadata Exchange Scheme)	http://www.ebu.ch/departments/technical/pmc/pmc_meta.html
IEEE: 1484.12.1 - 2002 Learning Object Metadata (LOM)	http://ltsc.ieee.org/wg12/

Many any other standards for multimedia asset management are present in the broadcasting industry. MXF as well as AAF or P/Meta is especially designed for post-production, while TV-Anytime focuses on delivery and consumption. But these metadata specifications are essentially used within

the broadcasting environment. One of the strengths of MPEG-21 is its potential to act as the vehicle to bridge the existing gap between the two worlds - that of the broadcasting world where the distinction between providers or creators and consumers is rather clear and that of the Internet where consumers are simultaneously creators. MPEG-21 can cover or ensure interoperability with the mentioned metadata standards either by providing directly the required functionality and tools, or by including references to those metadata files and enabling their common use. And in addition, it is possible to take advantage of all other value delivered by MPEG-21 such as DRM interoperability or DI adaptation and QoS awareness. For example, MXF can be mapped via MPEG -21 to consumer device readable formats such as TV-Anytime, DVB-HTML or other relevant XML based formats. The data contained in MXF structures is preserved as well the process of mapping can be automated.

The exploration of the use of MPEG-21 in broadcasting started with finding MPEG-21's key features and strengths. In specific content structuring as e.g. applied in the LOM is currently only available in production phases due to proprietary standards (e.g. MXF). MPEG-21 can be specifically applied in delivery phases and can be seen as middleware standard for advanced consumer device architectures. Intelligent middleware architectures matching low-level resources to high-level demands from application side are strongly supported by MPEG-21 and its adaptation and QoS features.

MPEG-21 provides therefore an excellent solution for solving issues such as QoS management, IPMP or adaptation in an excellent way and MPEG-21 already covers much other important area.

Work is continuing to provide firm ground for the broadcasting industry in digital switchover. In the near future we will be able to report about more advanced usage scenarios and their technical challenges.

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