

# Providing Interactive Services in Digital Video Broadcasting Networks

Uwe Kühhirt  
kht@idmt.fraunhofer.de

Peter Dunker  
dkr@idmt.fraunhofer.de

Andreas Haupt  
hpt@idmt.fraunhofer.de

Fraunhofer Institute for Digital Media Technology IDMT  
Metadata Department  
Ehrenbergstraße 31  
98693 Ilmenau, Germany

## ABSTRACT

The established digital video broadcasting networks can do more than transmit the ordinary TV program to the viewer's living room. The future of digital television will be interactive. Especially for local communities or people who are not familiar with computers, local cable networks can be an interesting alternative to the global Internet. We present a technology platform for using the traditional cable television network for an information and interactive service platform. In this paper we give an overview of an ongoing research project with focus on technologies for small and medium-sized CATV networks in cities and communities, hotels or companies. We present the overall workflow, the system architecture and its components, and some sample applications.

## Categories and Subject Descriptors

H.4.3 [INFORMATION SYSTEMS APPLICATIONS]: Communications Applications; H.5.1 [INFORMATION INTERFACES AND PRESENTATION]: Multimedia Information Systems

## General Terms

Design, Human Factors

## Keywords

Interactive TV, DVB, authoring, playout, media convergence

## 1. INTRODUCTION

In the age of digital media, without doubt the Internet is the most important medium to distribute all kinds of information and to provide interactive services to the user. However, the convergence of digital media will be one of the big challenges in the next years. Digital content, once produced, can

be delivered via an arbitrary digital transmission system to an arbitrary consumer device. The content description and encoding must be flexible and scalable regarding the technical parameters, e. g. available bandwidth, processing power, and display size as well as other parameters, e. g. the favored level of interactivity. So the user has the free choice, which system and which device on what place he wants to use.

Nowadays, the television set is mainly used for entertainment in a lean-back situation in the living room. Nevertheless, there is a rising demand for straightforward access to information and services using the TV set. Thanks to the advancing digitalization of the broadcast world also the seeming old-fashioned medium *television* is suited to provide information services and interactive programs to the users in a living room scenario. Based on broadcast technologies manifold kinds of information services can be realized for usage with an ordinary TV set. For more interactive experience adequate equipped set-top boxes are required, possibly combined with individual interaction channels.

Personalized news presented by your favorite anchorman, a local market place where you can sell second hand articles or the interactive quiz program about your hometown – these are typical applications of the system presented in this paper. Within the ongoing research project "Information services and interactive services on CATV networks" we are developing a technology platform for providing interactive services in small and medium-sized cable networks based on *Digital Video Broadcasting (DVB)*. Possible services can be in the field of personal television [1], enhancing content by interaction with parts of the TV program [2] or special information services in a local CATV environment such as webcam channels, weather channels, local TV game shows or bus schedules. Furthermore, new services will be developed which are designed in a creative and scientific organized environment [3].

The technology platform presented in this paper includes infrastructure components for operating CATV head-ends, authoring tools for the efficient content creation and the support of services, as well as components and applications for user devices. Services as described above can be managed with our playout system which has a flexible and extendable architecture. The system enables service companies to offer new programs, services, and contents as part of their business model. More information about the current services can be found in [4]. The most parts of the proposed system can be used also for other distribution scenarios, e. g. for satellite transmission or for mobile TV services [5].

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## 2. SYSTEM OVERVIEW

The system for providing enhanced services in a broadcast environment is divided into three main subsystems: the *Service Authoring Environment (SAE)*, the *Content Server (CS)* and the *Client Platform (CP)*. Figure 1 shows the system overview and the simplified workflow for content creation. The tasks of the SAE concentrate on the creation of enhanced services and content aggregation. The service authoring should usually be handled by a service provider who offers services and sets up the CS. The authoring informations are stored in a well adapted authoring format and separate media assets that are transferred to the content server.

The main tasks of the CS are the generation of services for playout, offering remote content management possibilities, a remote service scheduling as well as server system management. The CS is the technical basis for the collaborative work of several authors in the production of enhanced TV applications. It manages all of the resulting data and gives access to authors with respect to their individual privileges. For this, a flexible data management was developed. The CS is also the interface between the producers of media objects and the authors. Furthermore, it enables the reusability of services and elements in different applications.

On the client platform our activities concentrate on enabling current consumer devices to show the enhanced services. This includes the implementation of browser and player components as well as the design of user interfaces for *Set-Top Boxes (STB)* and for applications. Currently, we prefer Linux-based STB for prototypically implementations.

## 3. AUTHORING ENVIRONMENT

Our sophisticated authoring concept enables the creation of content independent of the chosen distribution format. Currently, we are using *MHP*, *MHEG*, *HTML* as well as *MPEG-4 BIFS* and *MPEG-4 LAsER* on several set-top boxes for distribution. The authoring concept includes a well adapted XML-based authoring format on a very high semantic level to describe services really independent of platforms, middlewares or distribution formats. An authoring format stores all of the resulting information for the description of enhanced services during the authoring process. It describes a service on a well adapted abstraction level and enables the exchange of service data with other authors and systems. We developed a special XML-based authoring format based on the *Extensible MPEG-4 Textual Format (XMT)* which fulfills the requirements of applications regarding abstraction level and functional range. Components for the processing of these authoring format were developed. Figure 2 shows the relevant data formats: at top the authoring format, in the middle the data transformations, at bottom the distribution formats and client applications.

Authoring tools are the interfaces provided by the authoring system to the authors. Interactive graphic tools for the support of an intuitive work during the authoring process are in the focus. A typical authoring tool contains several editors, which create and edit service data stored in XML-based authoring formats. Furthermore, service data can be edited at source code level. In the case of collaborative authoring an authoring tool is connected to an authoring server. An autarkic use is also possible.

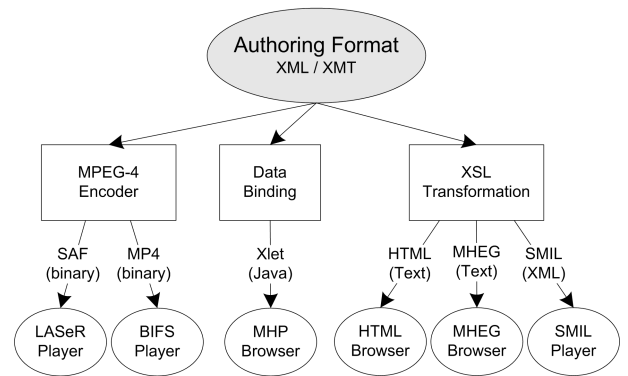


Figure 2: Data formats

In order to enable content creation for professionals and for non-professionals, we provide different well adapted authoring tools for three levels: a graphical authoring tool for experienced designers, a *template-based authoring tool* for service providers, and a simple *web-based data editing tool*.

The template-based tool is a wizard-based system to generate a complete service based on prepared service templates. Such service templates include also an animation scheme that defines a slideshow animation of the service content for a following rendering into a video-based DVB service. Furthermore, the authoring process includes service modules for an optional automatic content aggregation that are used within the CS.

The described components, that are needed for service assembly can be generated by a service provider and offered to customers. This components need to be transferred to the content server which integrates the new service in a service list.

One important point during the creation process of interactive applications is the user interface design. For this purpose we use sets of interaction design patterns that follow established design rules [6].

The developed concepts are oriented towards the requirements of our research project, but they are transferable to other kinds of multimedia applications. With these concepts and components authoring systems and tools can be realized, there are both universally applicable and specialized.

## 4. PLAYOUT SYSTEM

Several components have been designed to implement the outlined playout chain as depicted in Figure 1. All services and applications are hosted and managed on the content server, which is usually located within the CATV head-end station. The content and playout server consists of various components that are executed in an environment based on Java Server Faces, JBoss Application Server, and MySQL Database. It provides a means of overall system configuration as well as scheduling of streaming sources, content transformation, and controlling the multiplexer. Individual components e.g. the MPEG-2 transport stream multiplexer and several encoders are C++ implementations and interact via UDP communication. If a return channel is applied the content server might react on viewers interactions transported over HTTP. Figure 3 shows the system components and the interaction between content server, multiplexer, and

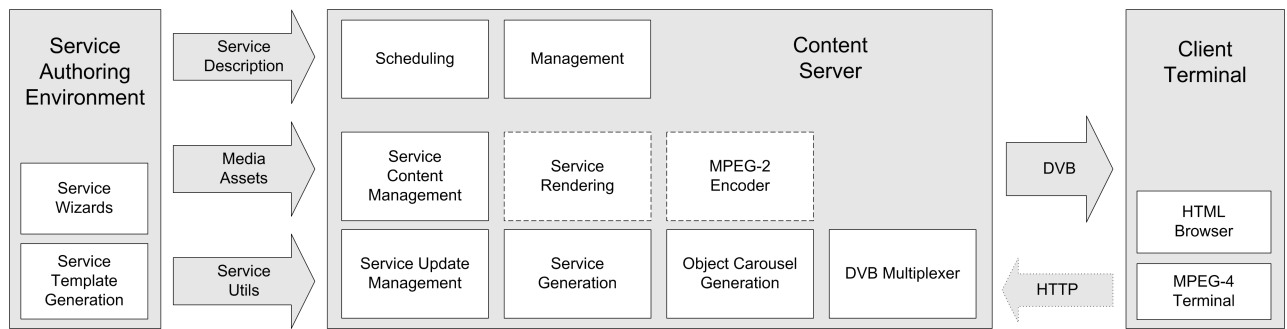


Figure 1: System overview and principal workflow

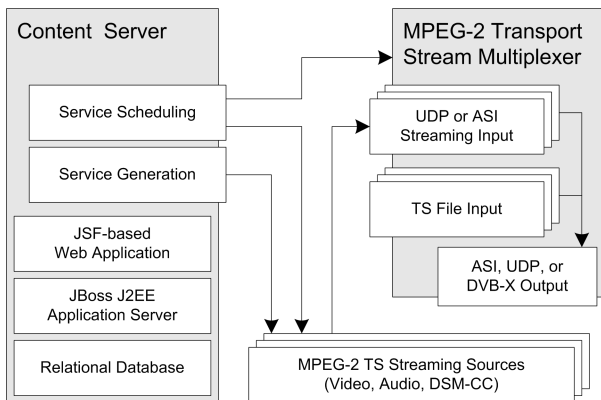


Figure 3: System components and interaction between content server, multiplexer, and data sources

data sources.

The service generation part includes at first an automatic content aggregation, in case the service uses these methods. Usually unique identifiers describe special external information sources that are needed for a service. The aggregation could include e.g. webcam capturing, website parsing/scraping or remote sensor device input such as weather stations. The next step is the service preparation and conversion to a selected distribution format e.g. MPEG-4 LAsER, MHEG-5 or MHP. Subsequent an object carousel generator is used to generate DSM-CC sections for a MPEG-2 transport stream which are afterwards included in the DVB multiplex. Another option for service generation is the rendering of predefined views of an existing service into a slide show for non-interactive viewing. A following MPEG-2 video encoding of the rendered service and the usage within the DVB multiplex integrates the service as a fully-fledged DVB channel. This method allows the content server operator to transfer service information to all recipients using any kind of DVB receiver. Such an option can be used as a promotion feature to convince users of the additional benefit of the rough sketched service.

Next to the automatic content aggregation a manual content input by non-experts is usually needed for the various kinds of services e.g. news or contact data. This functionality is usable in a very flexible way; therefore a web-based interface is integrated for content management. This enables content management from every working desk with an internet connection.

The service scheduling offers a web interface to define the service broadcasting similar to the service content management. Therefore the user can select an available service from a list on the content server. This list can be updated with additional services by the service provider. The scheduling defines the temporal order of the rendered services for the DVB channel as well as possible active or non-active times for the interactive services. The scheduling of streaming sources includes triggering of external modules such as MPEG-2 encoders or DSM-CC generators.

The server administration includes low-level system configurations which are usually set up once by the service provider that supports the content server. User administration and role assignment allow the restriction of the servers functional range to the given requirements.

The real-time multiplexer is the core component of the content server and combines all available data sources. This multiplexer runs in a 24/7 mode which means it works non-stop and is controlled by communicating with the content server and scheduling environment. It can handle incoming sources that are available as transport stream files on a hard disk or as streams arriving over UDP or ASI interfaces. Supported data sources include digital television and digital radio sound format e.g. from live encoders. Furthermore, transport streams from DSM-CC generators as described above are supported too. The appropriate signaling of service information is handled by the multiplexer. The multiplexers output can be supplied in miscellaneous formats like ASI, UDP, DVB-C, DVB-S, or DVB-T. The multiplexer core is written in C++ programming language and supports a wide range of common DVB devices, which are available on the market.

## 5. CLIENT TERMINAL

The selection or the degree of freedom regarding available devices depends on the data format that is activated in the scenario. Supported formats are described above e.g. MHEG-5 or HTML. A subset of the possible services can be used by every available set-top box on the market. Currently the presentation of the enhanced content on the viewers side is carried out by available Linux-based set-top boxes and *Home Theater PC (HTPC)*. We concentrate on enabling such devices to be able to handle the services. The software employed on the terminal device includes a HTML browser and a MPEG-4 client. For future STB platforms the *MPEG-4 LAsER* occurs especially interesting. *LAsER* stands for *Lightweight Application Scene Representation* and

is a Rich Media format dedicated to the mobile, embedded and consumer electronics industries. Inspired by some of the best digital media technologies, e.g. *SVG*, *MPEG*, *FLASH*, *BIFS*, etc., *LASeR* tunes and optimizes each required feature to effectively respond to the need of an efficient open standard for Rich Media. [7], [8]

## 6. SAMPLE APPLICATIONS

The described applications are supposed to be examples of content for the presented system for providing interactive services in CATV networks. Nevertheless, the ideas are transferable to any kind of delivery, e.g. satellite, terrestrial or mobile.

One possible application is the *CityWiki*. The idea of this service is to offer interactive applications in which the end-user is able to directly influence the broadcasted content. The basis for this application is a city wiki. This is an internet-portal containing user-generated content. All important information about a special place as for example daily news or the schedule of the local cinema should be inserted by users themselves. Thus everyone can participate in content aggregation. In a second level special topics of the wiki-page will be transformed into a format that makes it reusable for the interactive applications. Thus it is possible to insert text as well as pictures or even media-files into the application. The transformation will reuse XSLT technology. The broadcasted service is aimed to be in addition to an existing TV program. Illustration of content is certainly adapted from the appearance in the internet to the spatial resolution of the television environment. In a third level additionally to the standalone information beside the TV program the system will also offer linked information connected with the TV program. Special symbols on the screen lead the viewer to extra topics, which are available supplementary to the ongoing TV program. Naturally the topics are thematically combined with the ones of the program. This way of assembling content is a possible way of allowing the user to interact with the ongoing program. Thus this example shows a possibility of how the user can be actively involved in the aggregation of broadcasted content instead of just being a consumer.

A further application on the same technical basis is a *History Portal*, that gives the users the opportunity to talk about stories and tales from their past with positive effects regarding the transfer of cultural identity between subsequent generations.

A second example is an *Interactive Quiz*. Main part of this service is a quiz show transmitted as an ordinary TV program. Additionally, an interactive quiz application is provided in parallel. During the running show the user can answer the proposed questions in real-time in front of the TV set with his remote control. After some time the user gets a feedback about the correctness of his answer. It is evident to offer a feedback channel to this kind of application. This channel has to be synchronized with the TV channel to ensure that the answer is connected to the belonging question of the TV stream. In a second stage of the quiz a high-score should be offered which gives the participants an overview on how they played in comparison with others. Even the user should be able to install a profile of himself that can be shared with the provider of the service. This allows a later benefit for the users with an overall highscore.

## 7. CONCLUSIONS AND FUTURE WORK

Within this paper we presented the current work of the ongoing research project "Information services and interactive services on CATV networks" with focus on the overall system architecture and the playout components. The playout system is based on a highly flexible architecture to extend it easily to different future needs e.g. in future research projects in the field of digital TV. The core components can be used with different kind of input and output formats and interfaces such as UDP streaming or ASI interfaces as used in professional environments. Most of the components and methods will be also applicable within other transmission scenarios, e.g. for satellite TV and for mobile TV via DVB-H or T-DMB [5].

We depicted the workflow for service authoring and enabling within the playout and content server and described possible approaches to enable service providers to support the presented architecture. Finally, we presented some sample applications in order to give impressions of the systems opportunities.

Beside the future improvement of the core system components, we are developing different kinds of enhanced services and we will evaluate this in a field trial in a mid-sized CATV network.

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