CUSTOMTV WITH MPEG-4 AND MPEG-7


Abstract

The television industry is currently undergoing changes with historic proportions, posing tremendous challenges and opportunities. The CustomTV project ACTS AC360 is addressing the crucial problem of how, in the near future, viewers will be coping with the proliferation of TV channels as well as navigating through the masses of multimedia information that is likely to be broadcast thanks to digital technology, alongside with the conventional TV programmes. In contrary to proprietary approaches, a special view is given to the question, in what way the existing or emerging standards MPEG-4 and MPEG-7, which are also very likely to be used in the internet world, can add value to digital television services. CustomTV has developed and realised sample scenarios that demonstrate added-value services based on key features identified for these standards.

1 Objectives of CustomTV

Many of the currently existing or upcoming digital broadcast services already provide some means for navigating through channels and added value services, as well as for the implementation of these services. However, these mechanisms are based on proprietary solutions that bear the risk of incompatible solutions in the mid-term future and finally for an only slowly increasing acceptance of digital television. After having not addressed this area during the first project phase, DVB now has to put great efforts into establishing an MHP-standard for added value services. However, there are already international standards available that allow for the realisation of important features in advanced digital services, namely what CustomTV calls “object-based interactivity” and “programme and sub-programme selection”. These capabilities are strongly related to the established or upcoming standards of MPEG-4 and MPEG-7, which form the basis for the work of the CustomTV project [1]. CustomTV realised that these standards obtain increasing interest within the internet world and therefore tries to establish a closer link between digital television and internet applications.

In order to promote common approaches and their advantages in the above mentioned areas, the CustomTV project demonstrates the compatible insertion of both MPEG-4 multimedia elements and MPEG-7 like data into the conventional MPEG-2 data Transport Stream (TS). Interactive programme selection and user-determined screen customisation supports the user-friendly display of these multimedia elements (video, audio, navigation and other data). The description of events and contents is in accordance with the emerging MPEG-7 standard. A demonstrator has been built up consisting of a real-time receiver system and a satellite link, provided to be able to play out the data from a server and transmit it to the receiver in real-time. The demonstrator has been shown at IBC'99.

CustomTV is based on the premise that the future TV sets will have to provide the functionality to select and present information and services according to each user's preferences/profiles. The objective of CustomTV was to utilise the existing standardised digital broadcast technology for transmitting all forms of multimedia information on top of normal digital TV channels without necessarily requiring a return channel. All streams should be associated with metadata descriptors that could then be used at each receiver to customise the information received. The screen display can be organised according to viewer preferences, that are established by an easy to use interface and pre-recorded user profiles.

CustomTV relies on three main technologies: MPEG-2 for transport of existing normal TV channels and private data, MPEG-4 for the broadcasting and manipulation of multimedia information in order to support “object based interactivity” and MPEG-7, currently being developed, for the transmission of indexing and filtering information in order to enable “programme and sub-programme selections”. As an

1 The term Programme encompasses all types of content in the channel data stream, such as TV, audio or multimedia elements.

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enhancement of the current DVB service, the MPEG-4 and MPEG-7 elements had to be included as additional information in ordinary MPEG-2/DVB Transport Streams without corrupting the information already present. Thus ordinary DVB receivers will receive the basic information, as before, while enhanced receivers (as the prototype developed in CustomTV will be able to fully utilise the enhancements in addition to the basic digital TV service. As a further objective, CustomTV focuses to maintain compatibility with the emerging DVB-MHP standard in order to enable a smooth migration of the techniques developed into real services using next generation DVB platforms.

After 18 months duration the project was planned to be finished in November 1999, but is now extended for another 3 months. The SAMBITS project which is likely to start in early 2000 within the European IST programme will exploit the results of CustomTV with a wider view towards DTV and Internet.

2 Applications and Scenarios

2.1 Project approach

After an initial analysis of (proprietary) systems that realise interactive and added-value services in DTV, it became obvious that many – however not all - features of these proprietary solutions can be realised with MPEG-4 and MPEG-7 mechanisms as well as that these standards provide certain key features that add further value to digital television. Use of these standards in DTV will also support the convergence of broadcast and internet worlds. The still missing component is a way for downloading applications. This was reflected by the project by choosing Java as a basis for most modules, which would also allow for a smooth migration towards integration into a DVB-MHP-based platform.

As a consequence, CustomTV identified the unique key features of MPEG-4 and MPEG-7 and developed key scenarios for interactive customised applications that make use of these features. Three scenarios were finally selected for implementation and demonstration.

In parallel, three contributions to the MPEG-7 standardisation process supported the broadcasters’ requirements for indexing and selection of broadcast services. These contributions [2,3,4] introduce basic functionalities already provided by DVB service information to the world-wide MPEG body, but extend beyond that and include e.g. mechanisms for advanced bookmark functions.

2.2 Key features of MPEG-4 and MPEG-7

The following key potential for creating added-value in DTV applications by MPEG-4 was identified:

- **Coding efficiency for small bitrate**: MPEG-4 can effectively be used for transmitting supporting information such as trailers, context sensitive ads, etc. in parallel with the higher quality MPEG-2 programme.
- **Object based coding**: An object based representation allows for advanced interactivity and indexing with single objects.
- **Simple scene manipulation**: The MPEG-4 scene description mechanism (BIFS) supports quick and easy manipulation of scenes at the transmission or reception end.
- **Inherent "local interactivity"**: The BIFS mechanism already supports a scene manipulation, e.g. by mouse events and movements. This allows to generate buttons of arbitrary shape as well as to define the behaviour of whole interactive scenes without any other mechanism.
- **2D and 3D representation**: With high performance end-terminals, a smooth transition to 3D scenes and 3D interactivity is guaranteed.

The emerging MPEG-7 standard will have a much wider view than "just" digital broadcast. However, the following key features are expected in this area:

- **Classification and information on objects**: In combination with the object-related functionality of MPEG-4, this opens a way for adding information to individual objects within a scene. This information may e.g. be accessed after local selection.
- **Classification and information on events and "sub-events"**: In the temporal domain, a very granular indexing of programmes (e.g. of a goal in a soccer game) can be realised. Such a short scene of a whole programme event is regarded as “sub-event”.
- **Advanced linking and filtering**: The above mentioned features can effectively be used to implement cross-links between multimedia elements, bookmarking functions and filter mechanisms for objects and “sub-events” in order to support customised programme selection.

All these features provide a great potential for creating added-value in advanced and customised DTV services in a standardised way. Based on these features, a series of key applications were identified and the subset described in the following chapter was realised. Furthermore, it was decided to realise all applications without a return channel.

2.3 Key added-value services

In order to realise these selected services, an enhanced DVB compliant Transport Stream carrying all the necessary data was created offline which contains several MPEG-2 channels, MPEG-4 and MPEG-7 data. The MPEG-7 data delivers content description data, which is associated to the MPEG-2 programmes
and MPEG-4 streams. It describes the content of these programmes, sub-events or objects by the use of previously defined keywords. Based on these keywords, the CustomTV demonstrator is able to select content according to the viewer’s preferences. With the use of MPEG-4, the viewer will be able to interact with objects on the screen, can select items out of menus and can choose the position of additional information on the screen.

In order to demonstrate the use of MPEG-7 and MPEG-4 to enhance ordinary MPEG-2/DVB transmissions, CustomTV has prepared three different demonstration scenarios:

- **Enhanced EPG** (Selection of programmes according to user profiles)
- **Data services** (Stock rates and flight table application)
- **MPEG-4 interactive services** (interactive weather application)

### 2.3.1 Enhanced EPG

The enhanced EPG application shows a smart way of selecting channels on a TV screen. When starting the application, QCIF sized MPEG-4 trailers of four running TV programmes that were automatically selected with the help of MPEG-7 indexing information are shown on the screen (Figure 1). When a trailer gets the focus by clicking, it will be blown up to CIF size (Figure 2). The layout of the trailers and the response to mouse events are fully encoded using MPEG-4 BIFS. At the same time very brief programme information is displayed at the bottom. Here, the user can either ask for more information about the programme corresponding to the trailer, switch to the actual programme or give focus to another trailer.

What trailers to be shown is based on user profiles or user preferences, which could be interactively set up by the viewer using a profile editor. Preferences can be given by selecting categories or sub-categories of programmes and using a slide bar indicating more finely the users preferences.

### 2.3.2 MPEG-4 data services

While watching MPEG-2 encoded programmes, as in the enhanced EPG scenario, the user is allowed to click a button to access additional data services. CustomTV demonstrates two sample services:

**Flight information:** A user interface provides access to several airports in order to display and track arriving or departure flights. The user can select one or more flights and place them anywhere on the screen for tracking it, e.g. to note when a plane has landed.
Stock rate: Similar to the flight information, a table of many different stock rates is shown on the screen (Figure 3). By clicking onto a stock-rate it can be selected to be tracked. The tracked stock-rates can be freely placed at any position on the screen. BIFS update commands in the MPEG-4 data are used to refresh the value of the tracked data. Additional information of a stock-rate can be accessed via the info button (e.g., graphic charts encoded as GIF-pictures in the MPEG-4 scene tree, informational text).

2.3.3 MPEG4 interactive services

The purpose of this scenario is to show additional features that MPEG-4 provides compared to MPEG-2 and similar standards. An application has been set up where weather forecasts for several European countries (Figure 4) can be shown. When clicking on different countries of a European map encoded in MPEG-4, forecasts for local regions will be shown. Additional text information, still pictures or videos with associated audio from the different sites are also included. The interaction with the display is fully based on the MPEG-4 scene description (BIFS). The video component contains several objects that can be manipulated and associated to different pieces of additional information.

Figure 4: European Weather forecast

3 System implementation

The CustomTV system is separated into the server side and the client side. The server side comprises provision and (offline) processing of all content needed to make and demonstrate such enhanced services.

3.1 Content provision

For MPEG-2 encoding of the CustomTV content, a commercial MPEG-2 encoder was used (MP@ML for video, MPEG-2 Layer 2 for audio). The weather forecast has been created in a virtual studio.

For MPEG-4 video encoding the MoMuSys video encoder software was used. The trailers have been encoded in QCIF size at 25 frames per second. Audio has been encoded according to the AAC (Advanced Audio Coding) standard at 128 kbps.

Since the development of the MPEG-7 standard has just started in parallel to the activities within CustomTV, no assisting tools for generation of relevant descriptions were available. Therefore, in a first processing step the content of the static and dynamic descriptors are manually edited by the aid of a professional table-processing tool (MS Excel). In the second processing step a software module called bit stream generator reads the data from the text file generated in the first processing step and prepares the bit stream file for multiplexing and transmission (Figure 5).

Figure 5: Scenario of manually generation of MPEG-7 descriptions

Currently, no further compression is applied to the indexing data. The system multiplexing was carried out as shown in Figure 6. The final transport stream was stored on a server for real-time feed of the receiver.

Figure 6: Multiplexing scheme
All the MPEG-4 material has been multiplexed using the MPEG-4 FlexMux. MPEG-4 and MPEG-7 data were finally packetised as private sections into the MPEG-2 Transport Stream in order to prove backwards compatibility with existing MPEG-2 DVB services.

### 3.2 Terminal processing

Decoding of all data streams within CustomTV requires real-time processing of MPEG-2, -4, and -7 data (Figure 7). After reception of the satellite signal, the CustomTV data extractors send data-packets derived from the private sections of the Transport stream to either the MPEG-4 or MPEG-7 Engine.

![Figure 7: CustomTV client-side](image)

A commercial MPEG-2 Integrated Receiver Decoder (IRD) receives the RF signal from the antenna, and outputs video and audio.

![Figure 8: MPEG-4 Engine](image)

For MPEG-4 decoding soft- and hardware-tools for demultiplexing, decoding and composition have been developed within the project. The MPEG-4 Engine (Figure 8) allows the simultaneous decoding and rendering of up to 4 QCIF videos at 25 Hz frame rate and decoding and playback of one stereo MPEG-4 AAC audio stream by using a newly developed DSP accelerator. QCIF sized video can be zoomed to CIF size by application of a software based renderer using OpenGL. The MPEG-4 Engine renders the MPEG-4 scene specified by the User Interface (UI) and outputs a video and an audio channel.

Due to the very initial phase of the MPEG-7 standardisation process, software tools for encoding, decoding and creation of descriptions were not available. They have been developed within CustomTV and the set of descriptors required for the demonstration has been defined within the project. The MPEG-7 like description scheme used within CustomTV is based on three proposals of the project which were contributed to the MPEG-7 standardisation process [2,3,4].

![Figure 9: MPEG-7 Engine](image)

The MPEG-7 Engine (Figure 9) was designed to enable the following functions:

- Receive the MPEG-7 data stream from the multiplexer via a receiving module and decode the data stream.
- Provide a list of channels that fit to a requested category.
- Handle incoming events from the User Interface (UI) via a communication module. After the user interface has indicated to the MPEG-7 Engine what kind of events are of interest, the events have to be detected and the type of event and a potential textual description of the event will be delivered.
- Deliver additional textual description that may be included in the MPEG-7 data stream for a requested channel or for an object within the scene of a requested channel.
- Provide a list of channels if a certain textual descriptor fits to a given string like the name of an actor or type of an object within a scene.

The User Interface (UI) provides the facility to set up a user profile, displays information about programs, menus, prompts, etc. In order to do so, the User Interface receives the information from the MPEG-7
module. The information for the profiles (e.g. what categories the user can select) is stored at the UI. When the UI starts up, the profile is read, and the interaction with the MPEG-7 selector is initiated. The items the user can select are being updated by messages coming from the selector. The UI is connected to the MPEG-4 Engine for the transmission of specification for rendering.

The Compositor in the CustomTV system is split into the Low-level-compositor and the High-level-compositor. The Low-level compositor is responsible for all compositing of MPEG-4 objects, based on BIFS information. This means, the composition of all MPEG-4 video- and audio-objects according to the scene-description. The MPEG-2 and MPEG-4 audio and video signals are composed by the High Level Compositor to get the final image.

3.3 Migration objectives

Currently, the CustomTV receiver is based on several PC platforms. As mentioned above, MPEG-4 and MPEG-7 do bring advanced capabilities to DTV in a standardised way, but still require additional applications and related download mechanisms in some cases. Therefore, a key objective was to preserve as much compatibility as possible with the emerging DVB-MHP system. This also opens an introduction scenario with soon existing receiver platforms. The modules of a CustomTV receiver as depicted in Figure 7 comprise many elements that exist in a conventional MPEG-2 set-top box. Additional modules, such as the high level compositor are likely to be implemented as on-screen function of the MPEG-2 decoder chip (however, for MPEG-4 objects, an alpha keying function will be required). The user interface and the MPEG-7 engine which only require lower processing power, may be implemented into first generation MHPs by download of Java code, probably without any modification of these platforms. Of course, the MPEG-4 engine requires more performance and will not work as real-time application on a first generation MHP. However, next generation systems may be able to handle at least smaller objects at lower frame rates, which is exactly the area where a lot of added-value can be created. In any case, these second generation platforms will have to cope with the performance challenges that arise from the expected convergence with internet terminals.

4 Results

The scenarios presented were probably one of the first applications that make use of MPEG-4 in a true broadcast push service, which required to take care of software compliance with special respect to synchronisation issues. Furthermore, the lack of authoring tools was experienced as major obstacle.

The interest in CustomTV’s system demonstration at IBC’99 was very high and attracted many parties from all over the broadcast chain. Obviously, the MPEG community was interested in seeing the achieved implementation with the standards they have been working on. Companies that are considering the development of MPEG-4 authoring tools received the confirmation that there will be a marker for their products in the very near future. Content producers and an astonishing amount of emerging multimedia companies explored the New Technology Campus in a search for new technologies. So did broadcasting companies, who are looking to extend their level of service provisioning and in some cases want to replace existing proprietary products.

Several open-ended interviews were undertaken with visitors at IBC, where participants were asked to rank specific aspects of the system for a selected scenarios well as provide more general comments. The interviewees were all male, IBC participants, between the ages of 24 and 50 years old, with background experience in the area of television broadcasting and research and development.

The results of the usability interviews indicate that, in general, the design of the user interface was satisfactory and that the underlying concept of the system was perceived to be of great value to the area of interactive television.

All participants found it fairly easy to interact with all of the system features, but suggested that the design of the remote control be reconsidered and the interface design be kept constant across all system features, in order for CustomTV to be ideally usable. Furthermore, CustomTV’s added value was seen to lie in the ability to specify the user’s preferences, the existence of the events messaging feature, as well as the programme information feature and its contents’ potential links to further information and the WWW.

5 Acknowledgements

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6 References

[1] CustomTV home page: www.irt.de/customtv
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