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Abstract

This report presents the achievements of the NexTV project. The objective of the NexTV project was to develop attractive concepts for consumer applications that demonstrate the viability of combining Internet and broadcast technologies. The focus of the project is on the possibilities that will be offered to the users of multimedia platforms for interactive audiovisual services that are based on open standards, such as, MPEG-2, MPEG-4, XML, HTML. Two interactive applications were developed in the project. These applications focused on the delivery and use of interactive content, myGuide and Toons respectively. MyGuide is an interactive extended electronic program guide. Toons is an interactive storytelling children's program. A business framework was developed that supports the stakeholders in the end-to-end chain with the exploration of new business models. Operational scenarios for determining cost and price level strategies were developed for the applications.

Keyword list

Interactive digital TV, Business models, Interactive applications, application requirements, user requirements, e-commerce, EPG, IPG, e-shopping

Contents

1. EXECUTIVE SUMMARY 7

2. INTRODUCTION 9

2.1. RELATIONSHIP TO IST PROGRAM OBJECTIVES 9
2.2. CHOICE OF APPLICATIONS 10
2.3. VIEW ON END-USER INTERACTION 11

3. APPLICATIONS 13

3.1. DELIVERY OF INTERACTIVE CONTENT: MYGUIDE 13
3.2. USE OF INTERACTIVE CONTENT: TOONS 21

4. BUSINESS FRAMEWORK AND REQUIREMENTS 31

4.1. NEXTV BUSINESS FRAMEWORK 31
4.2. INTERACTIVE SERVICE DELIVERY COSTING AND PRICE ANALYSIS 33
4.3. CRUCIAL ASPECTS 35

5. FEASIBILITY OF KEY TECHNOLOGY 41

5.1. MPEG-4 FEASIBILITY ISSUES 41
5.2. MHP FEASIBILITY ISSUES 43
5.3. MIGRATION OF MPEG-4 TOWARDS THE BROADCAST DOMAIN 44

6. CONCLUSION 47

7. REFERENCES 48

8. PROJECT OUTPUT 49

8.1. LIST OF PROJECT DELIVERABLES 49
8.2. LIST OF PUBLIC DEMONSTRATIONS 50
8.3. LIST OF PUBLISHED PAPERS AND PRESENTATIONS 51

9. CONSORTIUM PARTNERS 53

APPENDIX A 57

1. Executive Summary

The objective of the NexTV project was to develop attractive concepts for consumer applications that demonstrate the viability of combining emerging Internet and broadcast technologies. The focus of the project was on the possibilities that will be offered to the users of multimedia platforms for interactive audiovisual services that are based on open standards, such as, MPEG-2, MPEG-4, XML, HTML. Since consumers are at the end of the end-to-end TV chain, the quality of the services, programs and content that they receive and view is a cumulative result of all the processes that occur in the end-to-end chain. That is, the end-user experience is created by all stakeholders in the end-to-end chain. The focus of the NexTV project was on the integration of technologies, but above all on new ways of enjoying interactive media content.

Major challenges were:
- Insufficient level of maturity of technology and tools
- Long learning curve for all stakeholders, especially consumers
- Complex technology and uncertainty about what functionality is the most desirable
- Need for open solutions for the development and take-off of the technology

Two interactive applications have been developed, which use MPEG-4, interactive DVB-MHP (Digital Video Broadcasting - Multimedia Home Platform) and web technology. These applications, myGuide and Toons respectively, focused on the delivery and use of interactive content. The applications were chosen in such a way that they provided ample opportunity to investigate and explore the availability and maturity of the technology.

The focus of the myGuide application is on the *delivery* of interactive content to the home. The myGuide application is an interactive program guide for a general audience. The application provides personalized TV entertainment and information, integrates web and broadcast on the receiver, and provides E-commerce links via the TV. The users can choose content from different service providers and of different formats. Broadcast/narrowcast and web content are seamlessly integrated at the client side. Different media formats are combined in MyGuide and there are multiple concurrent providers for one client. Efficient and timely delivery of services is accomplished by means of the seamless scene composition of MPEG-2-encoded and MPEG-4-encoded audiovisual information. Two variations of the myGuide application were implemented, one using ATSC.

The benefits of the myGuide application are:
- Users have portals for accessing various services and content.
- Users of the interactive program guide can receive:
    - information about schedules of programs from third parties
    - personalized content based on their preferences
    - personal advertisement based on the program that is being viewed
- Users can shop in the virtual shopping centre and communicate with sales agents via a back-channel.

The focus of the Toons application is on the *use* of interactive content. The Toons application is a digital interactive story-telling application for children based on the technical possibilities offered by MPEG-4 and MHP technology. The application was developed in an iterative process in which users provide the input for the development of the interactive story. The interactive story consists of several different story elements, such as decision points, story lines and characters. The children can choose between these story elements during the actual broadcast and create a story to their own liking. The interaction with the story takes place via playful, tangible devices, such as a PDA or even more toy like devices. Three variants of the Toons application were implemented, one using MHP, one using MPEG-4 and one that allow experimentation with new tangible interaction devices.

The benefits of the Toons application are:
- Users have tangible devices to interact with the multimedia content within a program.
- Users can participate in the TOONS program to create their own personal experience.

- Users can:
  - modify, change and control the content
  - make their personalized version of the story
  - give input to the development of the story
  - configure the look of the characters in the story

Demonstrators of myGuide and Toons were presented at the IBC2001 in Amsterdam and the IST2001 in Düsseldorf.

A business framework was developed for the NexTV project. This framework supports stakeholders with the exploration of new business models and consensus building. A user-centric approach is used to capture volatile and uncertain requirements with the aid of a scenario-based methodology. Central to the business models is a new entity, the Interaction Manager (IM), which handles the relationships and transactions, including user profiles, between all the entities in the value chain. A cost model was developed to compare costing methodologies and their affect on price in the value chain. Two operational scenarios for determining cost and price level strategies for the myGuide and the Toons applications were developed in which different levels of interactivity for the end-users were accounted for. The interactive service market characteristics and usability aspects were also investigated.

The NexTV project set out from the assumption that the technology for developing interactive TV applications would be available and that there was only a lack for exciting applications and business models to advance the deployment of, especially, MPEG-4. We found that:

- There is still a long way to go to reach maturity for tools and technology and to achieve interoperability between the different platforms.
- In order to identify attractive applications for end-users which add value or that endeavour an unorthodox approach, the possibilities of these technologies have to be communicated in familiar terms to professionals in the media authoring and production domain. Participation in the IBC and presentations at conferences proved to be very useful for this purpose.
- The idea to have local interactivity, i.e., the viewer interacts with the content and not with a server appeared to be quite novel in our domain and elicited problems and issues that need to be resolved in further research projects. For example, the user interface architecture for the home systems or set-top box, the interaction amongst tangible interaction devices and with the program, synchronization and time dependencies of events in the program, in the user interface and in the user's perception.

Currently the maturity of MPEG-4 and DVB-MHP are not on an equal level and this had important consequences for the applicability in the consumer-oriented domain. With DVB-MHP, the basic content that the application is dealing with is streamed (MPEG-2) content in the DVB channel and additional content representations are not structured with regard to their interrelationship (dependency and timing). In contrast, the MPEG-4 standard is a large set of coding standards with a very sophisticated control layer. Parts of the standard are being deployed in the Internet domain but no selection (in MPEG-4 terms profile and level) has yet been made for broadcast domain applications. As a result of this the interoperability testing of applications and the conformance testing of MPEG-4 decoder implementations for the consumer domain has not been addressed at all. For these reasons the NexTV project had to choose a mixed solution for demonstrators that run on a consumer terminal, the Set-top Box.

The aim of extending the DVB-MHP standard with MPEG-4 is to achieve the useful combination of the Broadcast application domain with the interactivity of the Internet domain. From the user perspective it provides the ability to consume and interact with rich multimedia content. For the content provider, distributor and service provider it offers the framework of an international standard with al the benefits of interoperability, conformance testing and availability of tools, players and content. Combining DVB and MPEG-4 provides the ability to utilise very flexible and interactive application possibilities for the interactive broadcast domain. Transporting MPEG-4 content over an MPEG-2 Transport Stream or via a separate link using an IP connection enables the smooth (backwards compatible) and gradual introduction of advanced interactive content into the broadcast domain.

2. Introduction

The overall objective of the NexTV project was to develop attractive concepts for consumer applications that demonstrate the viability of combining Broadcast and Internet technologies. Two interactive applications have been developed, which use MPEG-4, interactive DVB-MHP and web technology. These applications are focused on the delivery and use of interactive content.

In the first year of the project the emphasis was on platform architecture choices, selection of applications and the methodology for the application development process. In the second year of the project the emphasis was on the implementation of the applications and the modelling of cost structure and price level strategies for different services and operating scenarios. In this development process we gained considerable experience with regard to what can and can't be done with the currently available tools and platforms. We learned how important it was to have very close cooperation between the production and the consumption side of the delivery chain. The applications were chosen in such a way that they provided ample opportunity for investigation and assessment of tools and platforms for implementation. The results of these investigations and experiences are presented in the next sections.

Promising technologies and attractive concepts for consumer applications can only survive when they are supported by effective and attractive business models for the interactive multimedia delivery business. The objective of the NexTV project is to provide a business framework in which the changing roles of the agents in the end-to-end delivery chain can be analysed. An inherent component of such a business framework constitutes the analysis of the application requirements.

The integration of existing new technologies to provide technical specifications for end-to-end systems was a core issue to address in the project. The objective was to do this by developing and extending software needed for the creation, delivery and consumption of new interactive services. This approach emphasised the strong dependency between commercial requirements and technical requirements.

2.1. Relationship to IST program objectives

The NexTV project was embedded in the IST programme Essential Technologies and Infrastructures. The project aimed to integrate and develop an end-to-end delivery platform for content, which could be real and/or synthetic, and may originate from different sources, such as broadcast and Internet. The project contributes to the objectives of the Key Action Line IV.4 and IV.6. The major contribution of the NexTV project to the program objectives concerned integration of technologies based on open standards (e.g., MPEG-4) for the end-to-end delivery chain, investigation of business models and their role in driving the application development, and investigation of the possibilities for the use of interactive content by end-users.

2.1.1. Participation in Concertation

The NexTV project participated in the IST E3 Concertation Meetings in the cluster Interfaces & Enhanced Services, Displays & Sensors, Signal processing & Mixed Reality Interfaces and in particularly in the sub cluster Interfaces and Enhanced Services. The NexTV project co-operated in this cluster in particular with the projects: SAMBITS, myTV, OPENISE, OCCAMM, and SoNG. All these projects deal with future multimedia platforms for interactive audiovisual services. They contributed to the further development and evaluation of open standards, such as, MPEG-2, MPEG-4, MPEG-7 and MPEG-21, TV-Anytime, DVB-ETSI, IETF, W3C and SDMI in the broadcast and Internet domains. Multimedia delivery platforms based on open standards for the production, delivery and use of interactive multimedia content were core to these projects. They all addressed a part of the end-to-end delivery chain.

The NexTV project organized, in co-operation with the SAMBITS project, a common demo for the projects in the IST sub cluster Interfaces and Enhanced Services at IBC2001 in Amsterdam. The objectives of this demonstration were:

- To demonstrate the achievements of the projects in the E3 IST clusters Interfaces & Enhanced Services and Signal Processing & Mixed Reality, Action Line IV.4.2 and IV.6.2 in a unified way at the IBC2001 in Amsterdam, September 14 –18, 2001.
- To communicate the strengths of collaboration in European R&D projects for advancing the state-of-the art in interactive digital television and multimedia services.
- To present the core research results of the participating projects in relation to the development of open standards and their importance for the development of enabling technologies for the end-to-end service chain.

The NexTV project participated actively in conferences and exhibitions that were supported by the IST, i.e., IST Diffuse Conference in Brussels, Future Media Conference in Florence, CAST'01, Living in Mixed Realities Conference in Bonn, and IST2001 in Düsseldorf.

2.2. Choice of applications

In the early phases of the project, NexTV identified typical application areas for interactive television. Those areas included education, entertainment, information, games, and shopping. While it wasn't possible to cover all application areas in the NexTV project, two applications were selected for implementation, which cover the areas entertainment, information and shopping.

General criteria for the choice of the applications were that they would:

- Highlight the possibilities of interactive television.
- Introduce new elements into their respective areas.
- Be economically feasible and sensible.
- Demonstrate the technical capabilities of the platforms used.
- Benefit the user.

Two applications were selected. These applications are myGuide, an electronic program guide (EPG) with integrated interactive shopping, and Toons, an computer animated TV program aimed at children, which allows the viewers to change the story and modify the look of the show. The main purpose of the myGuide application is to provide a portal for various services, most notably an interactive program guide and a shopping application, which are linked directly to the program currently shown as a video stream and the known preferences of the user, creating an immersive viewing experience. The main purpose of the Toons application is to provide children with an interactive TV program, which allows them to participate directly in the storytelling, by selecting alternative storylines, modifying the appearance of characters in the story, replacing elements completely and even allow the integration of objects of their own design into the program.

While the common purpose of both applications is to advance the state of the art in interactive television, their main focus is different. The myGuide application is an extension of currently available services. The two main purposes of myGuide are the provision of a stable portal for adding services to the normal viewing experience and to improve on currently existing separate services. Unlike Toons, the myGuide application includes the ability to provide an on-line interaction channel. There may even exist the possibility of employing bi-directional video communication, as in connecting to a live sales person with the interactive channel. The Toons application was designed as a new form of interactive television, allowing the viewer to directly participate and interact with the story presented in a TV program. While myGuide is more universal and builds upon existing services, the Toons application is more experimental.

The general objectives of the applications can be summarized as follows:

- To provide end-user interaction.
    - With programs and services.

  - Within programs with multimedia objects.
- To explore MPEG-4 migration into the broadcast domain.
- To demonstrate the applications in a real broadcast DVB-MHP environment.

The general requirements for the applications can be summarized as follows:
- They should focus on the delivery and on the use of interactive content.
- They should provide opportunities to investigate and explore the availability and maturity of the technology.

2.3. View on end-user interaction

Interactivity from the user's point of view was at the heart of the NexTV project. That is, to achieve compelling and enchanting interactive TV experiences the applications need to comply with at least one or more of the following requirements [1]:
- Provide feedback in the user interface.
- Provide users with control over the content,
- Enable users to participate in the program content,
- Give users the feeling or opportunity to produce something useful,
- Provide people with the possibility to communicate with others, and
- Make program changes depending on user behaviour.

These factors are the basic elements for the perception of interactivity for people to achieve an immersive experience.

Furthermore, interactive applications that are developed for the broadcast domain make use of the advantages of this domain with regard to the expectations and perceptions of people. These characteristics are taken for granted by their end-users. Examples of these characteristic properties are the quality of content and service, the familiarity of the medium, the structure and reliability of the programming, and the compliance with the need of people to belong to a community. TV programs are made by professional producers for targeted audiences. They are broadcast, live, in a scheduled timeslot, announced in advance and available as promised. That is, people can rely on the quality of the content and the quality of the service.

The specification of requirements for applications and their user interfaces is a notorious problem as it is difficult for people to tell exactly what they want. This is even more critical for the type of applications to be developed by NexTV, since the subjective experience of the end-user group determines whether the application will be a commercial success or not. A user-centred framework was chosen as the underlying application development methodology to cope with development processes prone to continuous changes and uncertainties. The NexTV deliverable WP1D2 [2] describes the initial user requirements for the applications. The framework distinguishes between three types of requirements:
- *Global Requirements*. These requirements describe restrictions and limitations that apply to the project and the applications.
- *Functional Requirements*. These requirements describe the tasks that the application has to do.
- *Non-functional Requirements*. These requirements describe the qualitative behaviour of the applications.

These requirements were used to generate the initial requirements for the NexTV applications. They were also used at the end of the project to assess the achievements of the project WP4 D4/D5 [3].

3. Applications

3.1. Delivery of interactive content: myGuide

The myGuide application is an interactive program guide for a general audience. The application provides personalized TV entertainment and information, integrates Internet and broadcast on the receiver, and provides E-commerce links via the TV. Users can choose content from different service providers and of different formats. Broadcast/narrowcast and web content are seamlessly integrated at the client side. Different media formats are combined in myGuide and there are multiple concurrent providers for one client. The integration of technologies is demonstrated on the DVB-MHP platform and on the ATSC platform.

MyGuide is the home page providing a portal to a plethora of content in the developing interactive television space, leveraging technology which supports multiple streams of rich media content delivery combining MPEG-4, MPEG-2, and Web standards into a compelling personalised delivery platform. The service will take full advantage of the rapid growth in the convergence of traditional and Internet media channels. One of the services provided by myGuide will be e-shopping which is an e-commerce application that presents some of the possible features that will be available in a near-future web-based virtual shopping centre.

The goals of the myGuide application can be summarized as follows:
- To make an interactive program guide:
  - Aiming at the general TV audience.
  - Providing TV entertainment and information.
- To integrate Web and broadcast content on the receiver.
- To provide E-commerce links via the TV.

The requirements for the myGuide application can be summarized as follows:
- Users should be able to choose content:
  - From different service providers.
  - Of different media format.
- At the client side:
  - Integration of broadcast, narrowcast and web content.
  - Multiple concurrent providers.

3.1.1. Scenarios for the myGuide application: User perspective

Interactive Program Guide

Unlike traditional references to an Electronic Programming Guide (EPG), myGuide is an Interactive Program Guide (IPG). Not only is information pushed and displayed to users, but the users have the ability to interact with the various components contained in myGuide. EPG features that are shown in the myGuide IPG include retrieving third party programming scheduling information that supports the user in his programme choice. The programme itself can also be displayed via the IPG.

In addition, the IPG prototype provides the ability for personalization based on user preferences on the system. The use of personalised information based on actual viewing habits allows myGuide to better tailor advertisements more effectively to the needs and interests of the user.

The screenshot in Figure 1 shows the different components of the IPG of the myGuide application.

E-shopping

One of the items that can be selected via the myGuide starting page is an e-commerce application that shows some of the possible features of a near-future web-based virtual shopping centre. In this example the customer gains access to the products of a Telco supplier. On the first page the customer gets an overview on the products available. By clicking on one of the products a new page appears of which the structure is shown in figure 2. Now a variety of options are offered to the customer: video advertisement, interactive 3D representation of the object, screen text providing more information on the item and a 'buy-me' button for online purchase.

The video advertisement is a broadcast commercial that describes in a humorous way the main features of the item, in this case it is a telephone set. This set is shown in the interactive 3D area in the upper right corner of the page (Figure 2). Inside this area the customer can inspect this set from any direction, he can change the colour combination of this set by clicking on the bi-coloured blocks located between the base station and the handset and he can listen to the different dialling tones that are supported by this set by clicking on the buttons of the handset. The `buy-me` button gives access to the manufacturer's web site, where an order form is filled out that can easily be linked to any e-shop system. At the customers request, this information can be stored away and automatically be filled into the order form when the customer asks for a new one thus avoiding the repeated input of information as name and address. The screenshot in Figure 2 shows the different components of the e-Commerce application of myGuide.

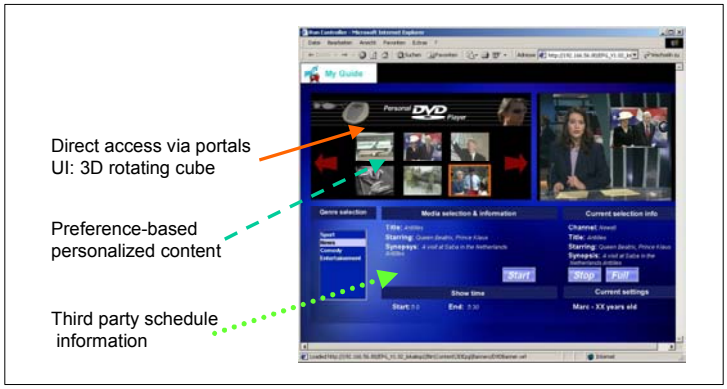

Figure 1: Screenshot of the myGuide application
Interactive Program Guide

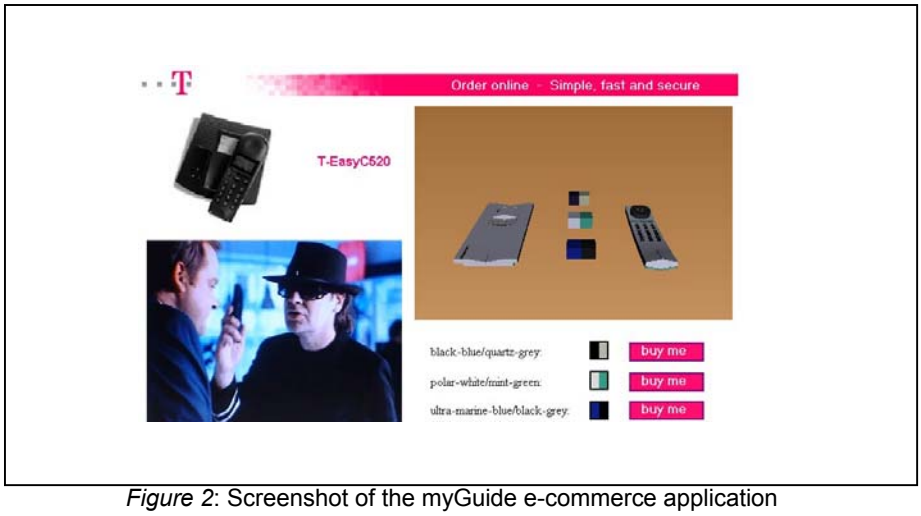

Figure 2: Screenshot of the myGuide e-commerce application

3.1.2. Scenarios for the myGuide application: Provider perspective

Content creators and suppliers are interested in delivering their products, films, other entertainment material or e-commerce presentations, to a broad public. Therefore the end user must be given information about where and when to find what. And this is the main task of the myGuide application.

The suppliers provide the publisher with content and information about their entertainment offer and about the commercials they want to present. This can be done in form of pictures, link addresses, complete web sites, textual descriptions and so on. The suppliers and the publisher have to agree on the design rules for the content to be delivered. The editorial staff puts all that together as a nice and attractive myGuide application.

The complete application is then delivered to a service provider, who integrates it into a portal and puts this and related materials on his servers. The service provider also takes care about the network requirements that can be different for mobile networks like UMTS, ISDN networks or broadcast. The service provider thus ensures that the end user is able to reach the myGuide application and all linked information on other servers or streaming machines via his network connection. Of great importance for the service provider is the fact that in the myGuide application all the tools for the presentation at the end user site can be provided as software solutions, which can be downloaded using telecommunication networks.

3.1.3. MyGuide Platform

The technical components that are needed to fulfil the requirements of the myGuide application can be derived from the schema in Figure 3.

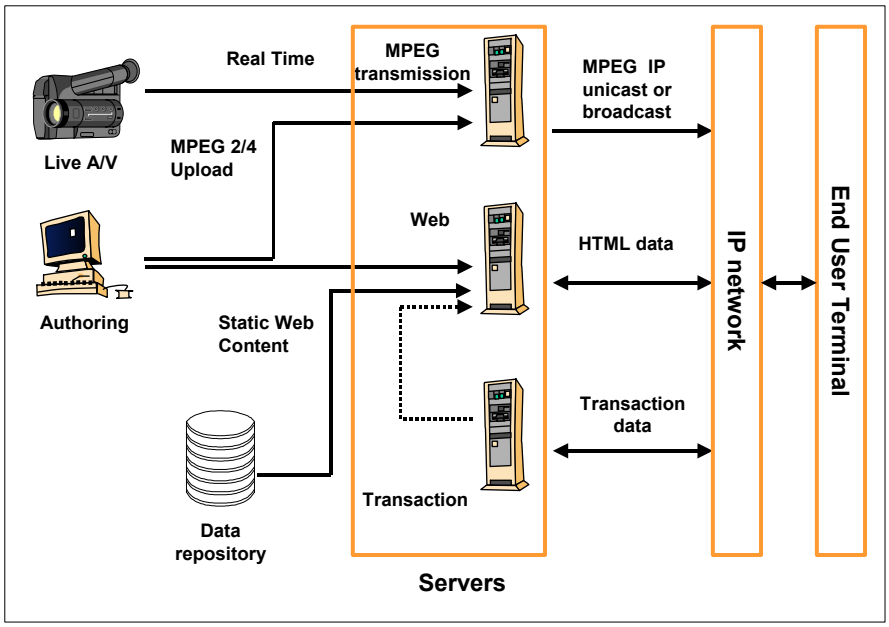

Figure 3: Components for the myGuide application

Content creation and distribution

The content that can be dealt with under the control of the myGuide application consists of a combination of temporal static and streaming information. The static part mainly contains HTML

pages made of texts and still images that structure the presentation surface of the application in a user-friendly and suitable way. The content creation is done using a PC-based authoring tool that delivers HTML files which are stored on a web server for general access over the network. In addition to the static content that is generated from the authoring tools to be delivered through the HTML files, there is also the requirement to incorporate third party data into the HTML pages. Such items of concern include television scheduling information, which is very critical for delivering an EPG application. It would make sense to include this mechanism with the HTML content that is delivered by the web server.

The handling of the streaming information depends on its future use. The camera in the previous figure symbolises the processing of live events. MPEG-2 or MPEG-4 encoded video and audio of live events can directly be brought on the MPEG-4 transmission server and transmitted from it. This server packs the incoming material into an MPEG-4 streaming format that can be streamed over the Internet in an unicast or multicast way.

For the processing of data coming back from the end-user, the transaction server is used. Such a server possesses the ability to activate programs which are fed and controlled by the back channel information of the application. For an e-shopping application this data normally is the order information that is selected from an order form, which is filled out by the customer. This transaction server is logically a separate unit in such a platform but the dotted line in the figure shows that this server can physically be merged with the Web server.

All this information coming from the different server tasks is bundled in the myGuide server, the functionality of which is hosted by the Web server. Information on the NexTV terminals capabilities is stored here as well, so that content is delivered to each terminal in an adapted manner. Individual wishes concerning the selection of content can be considered here as well as technical features of the terminal, for example, the screen size.

The transport of the data over the IP network uses the wide-spread software stacks that reproduce the appropriate layers of the OSI model. A safe connection for non time-critical information is realised via the TCP/IP stack, whereas streaming media are transmitted via UDP/RTP.

Terminal

To render all the different contents delivered by myGuide a PC or set top box is needed which has a demultiplexer, MPEG-2 decoder, MPEG-4 player and a Web browser.

The demultiplexer recognises the type of the multimedia content to be decoded and routes the file to the appropriate decoder.

The MPEG-2 decoder accepts MPEG-2 program and transport streams from the PCI bus of the PC and produces a video streaming format that is compliant to recommendation ITU-R BT.656. These digital decoded video streams are ready to be transferred to the graphics board for rendering. The decoder is powerful enough to support a full D-1 video (720 x 576 pixels) at a maximum rate of 25 frames per second. In the myGuide implementation an MPEG-2 software decoder is linked into the terminal that replaces the former hardware decoder. In this way, more than one software decoder for video in parallel could be handled, in this specific case the MPEG-2 decoder and the MPEG-4 player.

The MPEG-4 player that is used inside the NexTV terminal is a deliverable from the IST project SoNG that was adapted to this terminal's needs. The SoNG project (Portals of Next Generation) develops a technology platform that supports MPEG-4 based client/server as well as multi-user applications. Therefore, this player does not only contain a video decoder but also a BIFS decoder that supports the 3D scene composition. BIFS, the Binary Format for Scenes, consists of a coded representation of interactive audio-visual scene description information. A practical way of creating a 3D content for an MPEG-4 scene is using parts of a VRML description of a 3D scene. Due to the binary format of this description, the delay time for building up a 3D scene over a network is minimised. One of the benefits of MPEG-4 is the fact that MPEG-4 deals with visual objects whose shapes do no longer need to be rectangular. This allows a seamless scene composition of MPEG-2 and MPEG-4 encoded visual information. The video decoder that is currently part of the MPEG-4 player is laid out to support the

MPEG-4 Core profile. The MPEG-4 decoder is written as a plug-in software to the SoNG player and can therefore be easily exchanged for future improved versions of a MPEG-4 decoder that may also support other or new MPEG-4 functionality. The GUI of this player is used to browse through the MPEG-4 3D scene. The player itself is displayed in an Internet browser and is therefore also able to handle HTML content.

3.1.4. Implementation of the myGuide open IPG framework

MyGuide has been implemented as an open EPG framework that allows a wide range of functionalities depending on what services are targeted.
The design of this framework is shown in the following schema:

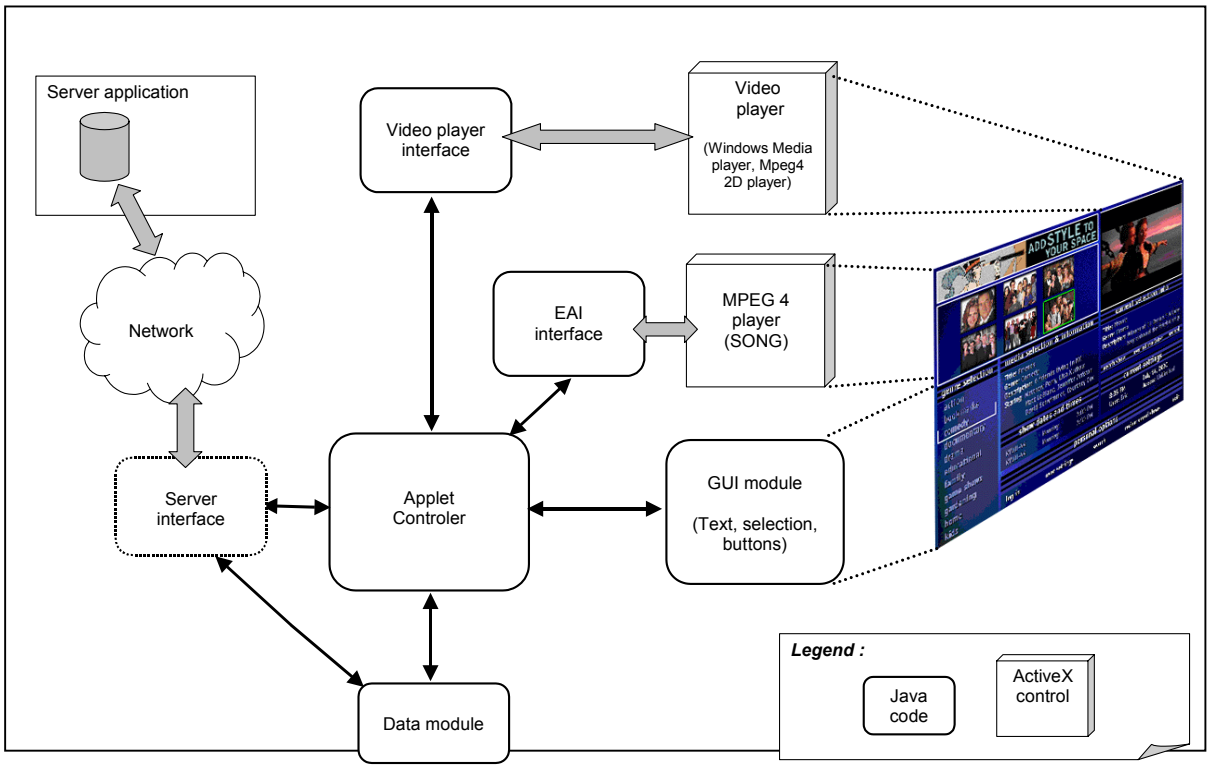

Figure 4: The open framework structure of myGuide

The controller applet is the core of the myGuide application, which makes the connection between all the other Java modules:

- The video player interface module allows control of the video player ActiveX control (play, stop, load, etc.). By modifying this module, different kinds of video players can be used (MPEG-2 player, for example).
- The EAI interface module allows control of the 3D player (e.g. Song player or Cosmo player). This module provides the methods necessary to manipulate the internal 3D scene and the call-back methods to receive events from the scene. Hence, through this interface, changing the banners or ads, or rotating the 3D cube to display categories by user click, becomes easy to handle and control.
- The GUI module displays several panels and buttons allowing the user to select a category - playing a selected movie or getting information about the currently selected movie or the one playing on the video player.

- The data module allows management of the data to be displayed in the GUI panel (categories, title, credits, time, summary, etc.). Currently the data is parsed from a local file, but through the server interface module, all the data can be retrieved through the network.
- The server interface module allows developers to connect to the network in a way convenient to them.

Elements within the myGuide open framework

3D panel

The 3D panel is used for service selection. It is divided in two main zones (Figure 5):

- Interactive 3D cube showing the categories with arrows
- Interactive banners on top

The user can click on arrows to change the selected category, click on thumbnails to selected a movie, or click on the banner to play the corresponding ad (see the following snap shot). The ad is played within the same player. A button (here “Exit to Menu”) allows the user to come back to the cube application.

Figure 5: The 3D panel of the myGuide application

The banner (Figure 6) can be changed dynamically by the controller applet thanks to the EAI interface. In our implementation, the controller replaces the banners every 10 seconds. This modification can be easily controlled from the server itself using the server interface.

Figure 6: The 3D interactive banner of the myGuide application

Interactive guide panel

The interactive guide panel allows the user to select a category with the mouse. When a new category is selected, the 3D cube rotates automatically to the right position in order to present the thumbnails corresponding to the category. In addition, when the user selects a movie, the information concerning it will appear (e.g. title, genre, description, credits, show date and times). The panel also shows information related to the movie that is currently playing in the video player window.

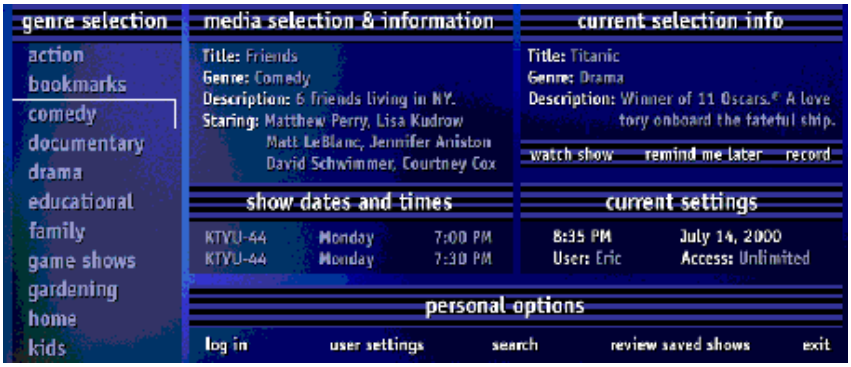

Figure 7: Example of an interactive program guide panel

Video panel

The video player starts playing the selected movie when the play button is clicked. The user has the choice of watching the video in full screen mode or as an insert of the EPG.

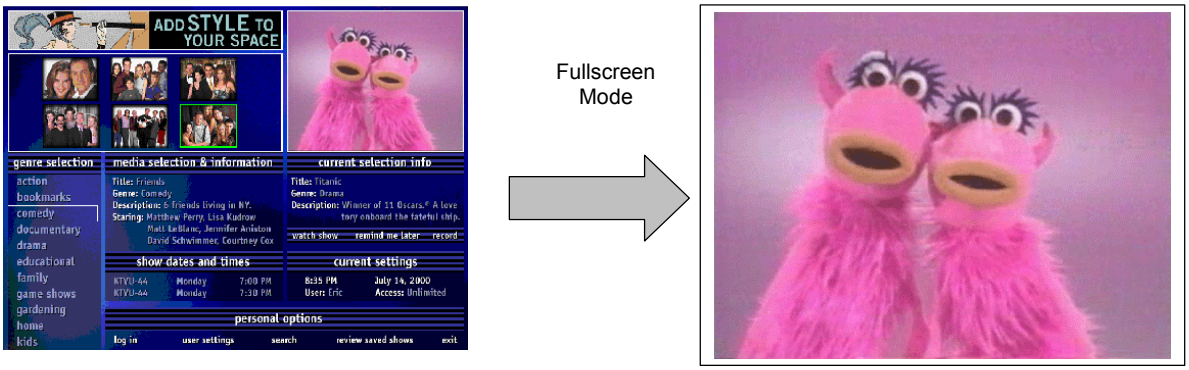

Figure 8: Example of insert and full screen modes

3.1.5. Technologies used in the myGuide application

The myGuide IPG incorporates various technologies to provide the viewer with an enjoyable interactive experience on a PC-based machine. The IPG is capable of delivering both MPEG-2 and MPEG-4 content through the interface.

The user interface for the myGuide IPG was developed based on the knowledge that a WWW browser would be the container for the application. Based on this prerequisite the IPG user interface was developed using technologies closely associated with WWW authoring. The technologies incorporated into the IPG include the Hypertext Mark-up Language (HTML), JavaScript, Java Applets, and ActiveX controls. In combining these technologies we were able to develop a user interface that is reflected in Figure 8.

To successfully provide an IPG that is representative of the real world, the prototype provides a means of playing MPEG-2 content. This was accomplished by using the Windows Media Player as the MPEG-2 player. The player is embedded into the IPG application using ActiveX controls.
In addition, an MPEG-4 player has been embedded into the prototype to incorporate interaction with MPEG-4 scenes. This provides the means for viewers to interact with components that are displayed in the MPEG-4 player, providing a true interactive experience.

The e-commerce application consists of an online shop that currently offers several telephone sets as sold by Deutsche Telekom. Stills images, text, streaming audio and video as well as 3D models are used for the presentation to the end user. The e-Commerce sub-application runs locally on several

computers. The application has been adapted to the needs of operation over a network taking into account spread resources for content and for the processing of application-related tasks.

For the description of this sub-application of myGuide the Digital Item Declaration Model is used, which is currently under construction in the MPEG-21 consortium. The digital item is the digital representation of an entity that is acted upon in a multimedia environment. This model shall be as flexible as possible and shall also be laid out to support future applications of which the structure is not yet known. For the declaration of digital items the XML schema is used in order to build up the syntax of a Digital Item Declaration Language that is abbreviated as DIDL. For more information on this language and its elements see document ISO/IEC WD 18034-2.

The project partner ETRI implemented the myGuide application on the ATSC platform. The application scenario is presented in Appendix A. For further information see D3 WP3 [7].

3.2. Use of interactive content: Toons

The overall goal of Toons was to develop an interactive story-telling application for children. The major challenge for this application was to create a compelling and enchanting interactive TV experience for the end-users. To achieve this goal the application needed to comply with one or more of the following requirements:

- Provide feedback in the user interface.
- Provide users with control over the content,
- Enable users to participate in the program content,
- Give users the feeling or opportunity to produce something useful,
- Provide people with the possibility to communicate with others, and
- Make program changes depending on user behaviour.

These factors are the basic elements for the perception of interactivity for people to achieve an immersive experience.

The Toons application is based on the technical possibilities offered by MPEG-4 and MHP technology. That is, MPEG-4 enables users to manipulate objects and sets of objects. Users can, for example, place media objects anywhere in a given co-ordinate system, modify attributes of media objects, transform appearances of media objects [4]. These specific properties promise to match the requirements for the Toons application.

The development of the Toons application consisted of several phases. First, an application scenario was developed based on input from the target end-users, i.e., children. This user input is also used to provide input for the creation of story content and for the design of an interactive story framework. This part of the application development is described in [5]. Second, the system architecture has to be able to handle different types of user interaction, that is, interactions initiated by the system and interactions initiated by the user. In order to accomplish interaction with the system and with the multimedia objects, users need tools or tangible interaction devices.

The interactive storyline was developed in two steps. It started by doing all the rendering at the provider end and after that by partially shifting the rendering and composition of the video scenes to the player. In the second phase, objects were modified. It started by changing the pre-defined appearance of the objects (customisation) and after that by changing the appearance of characters and objects in an arbitrary way.

The implementation of the Toons application was done in three versions. This was necessary given the state-of-the-art of the available tools and platforms. By focussing on user interaction with content within a program, the application challenged the available tools for realization. The first part of the implementation consists of a PC-based demonstration, which communicates the concepts and objectives of the application. In the second part a subset of the functionality was implemented on a PC platform using MPEG-4 functionality and a MPEG-4 player. In the third part a subset of the functionality was implemented on a Tri media set-top box using the MHP platform.

3.2.1. Scenario for the Toons application

The story and the content were developed in cooperation with the end-users. This story was structured as a story-line which consisted of different components that could be translated in technical production terms. That is, the story-line scenario has to be matched to a technical scenario to explain the technical structure of the story and the implications for available technology and platforms.

The target end-users of the Toons application are children in the age group 8 to 12 years old. The application should allow them:

- to create their own broadcast environment by positioning them in the role of program maker,
- to provide them with tools to interact with the broadcast environment,
- to make personal content.

The interactive story line is based on elements of the 'Old House' scenario, created by the NOB Virtual Productions and story elements created by children [5].

The story line contains three types of decision points. These decision points represent the different actions that users might undertake, i.e.,

- Choose an object to influence the storyline
- Add an object to be present in the story, without influencing the storyline
- Edit an object to select an emotion or mood for a specific character in the story

The children have tangible interaction tools in their possession to interact with the onscreen objects and streams. These input devices will provide feed forward and feedback in order to facilitate the interaction with the story. Feed forward can be obtained for example through light or sound in the input device to indicate what can be activated, what actions should be undertaken, and how actions can be achieved. This information must be broadcast by the broadcaster along with the story line: 'what actions can be undertaken at what point in the story line'. To enhance its effect, the story line should also supply information needed for the interaction, be it clues, voice-overs that tell the users that a decision point is at hand and similar things. The feed back provided by the input device should be immediate when actions are undertaken by the children. This can be in the input device itself, through sounds (*'click'* when a button is pressed) or light (an illuminated button that has been activated).

3.2.2. Acquisition of user input for the story

Input for the story was elicited from users. The procedure for eliciting the input from users and the results that were obtained are described in Deliverable D1 WP3 [5]. Children were asked to tell stories, to draw illustrations for their stories and to give ideas for possible ways and means to interact with the story. Figure 9 shows examples of the input from the children.

Figure 9: Acquisition of user input for the Toons story.

Story framework

The Toons story can be enclosed in a diagram depicting different parts of the story (Figure 10). In the opening sequence, a girl arrives at the gate of an old castle. Inside, an old professor is fiddling with bottles of liquid. Suddenly, there is an explosion in the laboratory and the professor finds himself hovering in the air, holding on to his green console. The girl goes into the house. In the first room she encounters the viewer can customise the appearance of the character. She can also select a key which will influence one of the story lines later on (Customisation & Objects in Figure 10). Then comes the first decision point (Decision Point 1 in Figure 10). The viewer can decide for the main character (the girl) which of the three doors in the house corridor she should enter, which converge later at the second decision point, from which the story can continue in three different ways, before ending in a common closing sequence.

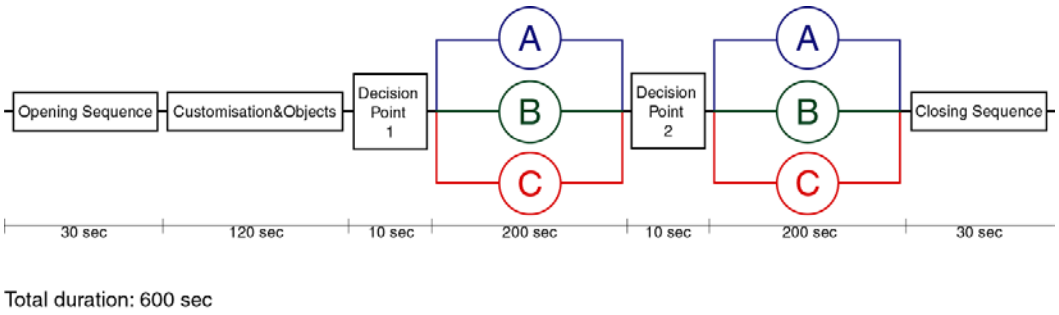

Figure 10: Framework of the Toons interactive story.

These interaction points can have a different impact on the story. Some of them will change the plot (for example, having chosen a butterfly as a pet, the girl will wander off to a different story branch and experience different adventures than she would if she had chosen the clock), others will affect only the scenery, not the story itself (for example, changing the outfit will enrich the scene but will not cause the story to take a different turn).

In short, the story is characterized by a non-linear narrative structure and by the multiple paths that a user can take during the viewing of the program. The effect for the users is that they are able to tell their friends: *What you see is not what I see, but we receive the same program.*

Storyboards were made to communicate the ideas of the scriptwriter to the programme producers. Storyboards are panels on which a set of sketches is arranged depicting consecutively the important changes of scene and action in a series of shots. In addition to drawings, they can also contain short textual descriptions of scenes. Figure 11 shows an example of a storyboard for the Toons application.

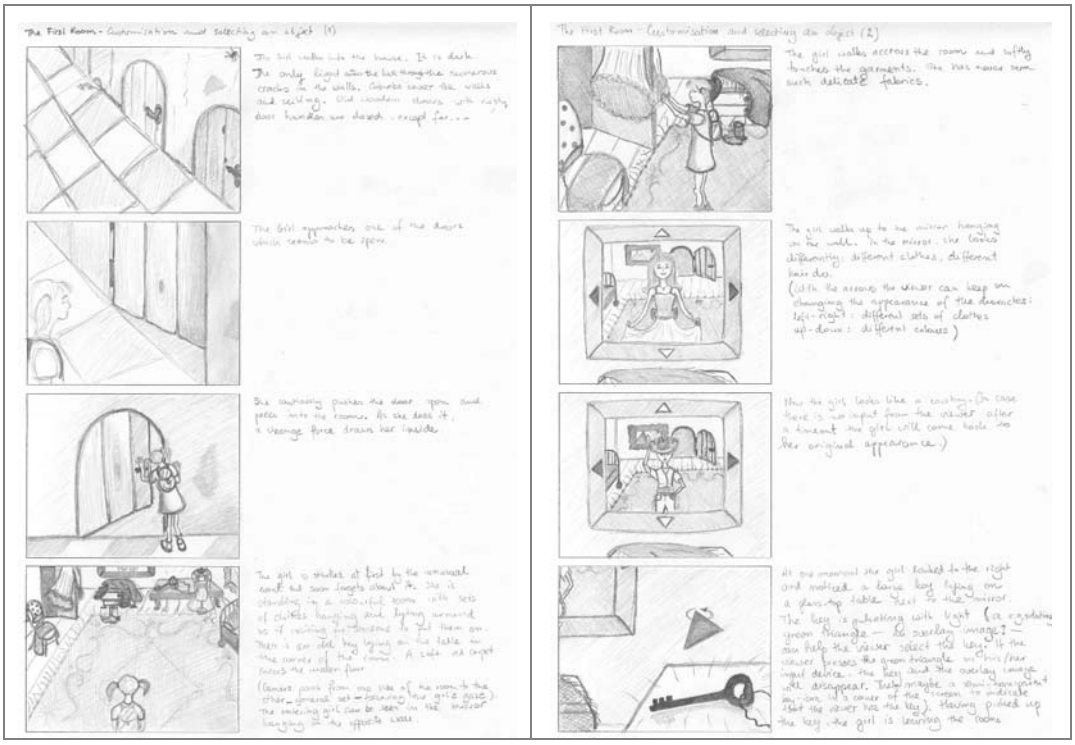

Figure 11: Storyboard panels for the Toons application

The user input, the story framework and the storyboards were used to create the content for the application.

3.2.3. Content creation

Manually controlling the appearance of some objects

First, a scene of the scenario is made in the modelling tool 'Maya™'. This scene is rendered and encoded to a single elementary video stream. The resulting video is imported as the main object in a BIFS-scene and the result is played on the 3d-player. The next step is to exclude an object from the prerendered video and to render it separately and in different versions. For example, rendering the room without the clock on the wall as the main video and separately render the clock on the wall in two different versions. A scene composed of the background video and the smaller prerendered clock together with the proper BIFS description will again be played on the player. We now have a simple scene graph. By changing the clock node we can change the appearance of the clock. This changing can be done by manually editing the BIFS description, at the terminal using some interaction script or it can be done by sending a BIFS-update command to the terminal.

Shifting the rendering partially to the player

By replacing the prerendered video in the node of the object by an 3D-description, it is possible to shift the rendering of the individual object to the player/terminal. Depending on the power of the player this rendering can be in different levels of complexity, starting by displaying a wire frame version only. This switching from using the prerendered object to rendering the object in the MPEG4-player can be done when the user wants to customise an object. For example, by replacing the texture of the object by a drawing the end-user has created itself. In a real life scenario a combination of both methods can be used to change the appearance of an object: for some often used objects, different prerendered versions will be broadcasted together with one synthetic description of the object (which can be rendered). For other objects only a synthetic description of the 3D-object will be broadcasted together with it's animation parameters. In this case there is no prerendered version available for the MPEG4-player.

Figure 12 shows how scenes were composed of different media objects.

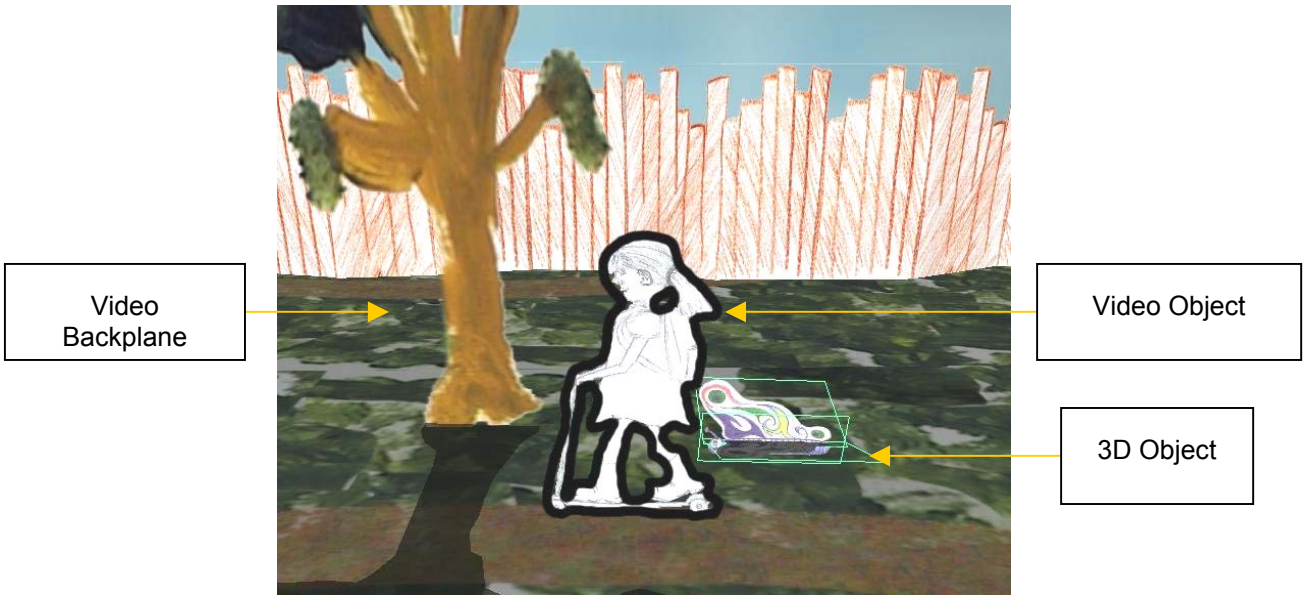

Figure 12: Content production: MPEG-4 scenes composed of different media objects.

3.2.4 Interactions in the Toons application

The Toons application is television centric and it is interactive, i.e. its content can be influenced in real time (to the extent defined by the program designer).

Depending on how the interaction is initialised, we can distinguish two types of interaction within this application:

1. Initialised by the application

The user can respond to the program at certain, pre-defined moments. The application invites the user to interact, giving information about an interaction possibility (feedforward information) and, as soon as the input is given, generates feedback information. The interaction will result in an immediate or delayed (depending on the story scenario) change in the programme content (even in the case of the delayed change, feedback has to be given to the user to inform her that the system understood her command). This user-system dialogue is time-constrained. If the user does not provide input within a certain (pre-defined) period, the application will proceed following a default path.

2. Initialised by the user

The user has a possibility to make changes throughout the programme, without an explicit invitation from the system side. In this case, the user needs to have a prior knowledge about such a possibility, for example, from the programme advertisement, trailers or information at the end of the last – or the beginning of the current - episode. An example of such interaction would be insertion of user's own (or a pre-defined) drawing in the story (e.g., adding a pet companion for one of the characters).

These interactions split down to lower level interactions, which are described in more detail in the next section. In general, users have the possibility to change the appearance of the main character, collect an object, choose the story line to follow and add an object to a scene. These interactions were chosen based on the information about children favourite activities and general interests, and the ideas of children themselves.

System feedback is one of the most important elements of any interactive application. In our programme, feedback is given after each user's action, in an auditory or visual form. Some feedback information will be a part of the story (e.g., one of the doors will open). Other will appear as an overlay on the screen (e.g., a key in the corner of the screen) or a graphical icon on the display of an input device (provided it has a display – thus, feedback will be accommodated to the available type of input device).

In the future, the application will be emitted on digital television systems, potentially equipped with an electronic data storage. The data storage may, but does not have to, be used, which will depend on the media streams (i.e., video, still images, audio, text, etc.) handling solution (for example, it may be desirable that some streams are downloaded to the local storage for further modification by the user).

3.2.5 Implementation of the Toons application

In addition to the consumer centred aspects of the application, Toons was also used as a technology showcase and test bed. The Toons application is based on the technical possibilities offered by MPEG-4 and MHP technology. Three main technological questions which arose from the discussions about the Toons application were:

1. What is possible today, using existing MHP technologies?
2. What is possible in the near future, using MPEG-4?
3. How does the user interact with applications?

To answer these questions, three variants of the Toons application were implemented, one using MHP, one using MPEG-4 and one that allowed experimentation with new tangible interaction devices.

The basic storyline followed in Toons is the same in all variants of the applications. This allowed us to create most of the animated content only once and concentrate on showcasing the specific elements inherent in the three variants, as opposed to animating and rendering completely new content for every Toons version. While the content had to be adapted specifically for the Toons variants (e.g.

MPEG-2 transport streams for the MHP version, video with omitted elements for the MPEG-4 version), characters, this effort was small, compared with the effort of creating three completely different sets of content. Using the same content base for all three versions also allowed the creation of a unified visual theme for the Toons application.

MHP variant

The MHP-only variant demonstrates an end-to-end implementation of the Toons application using DVB/MHP and MPEG2. Although the MHP-only version uses no MPEG-4 in the demonstration, it demonstrates the use of some MPEG-4 elements on a conceptual level and uses most of the production chain of the MPEG-4 application (Figure 14).

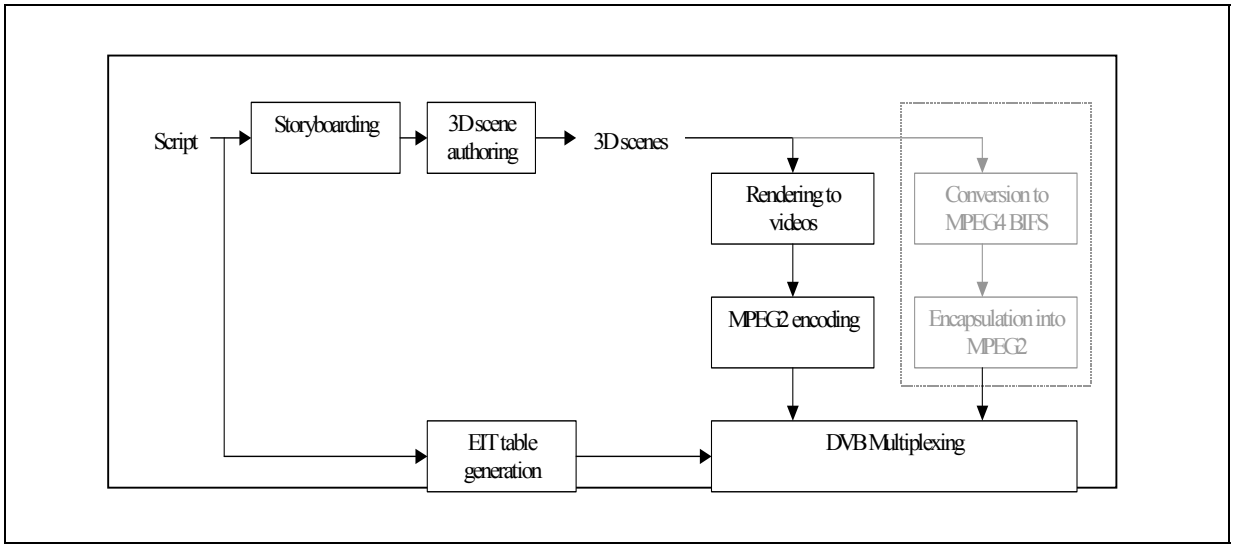

Figure 13: Production chain for the transport stream for the DVB/MHP- demo. In grey the additional parts needed for a combined MHP/MPEG4 version

In the MHP-only variant interactivity is demonstrated using MPEG-2 video streams. The video streams contain combinations of possible MPEG-4 objects. By showing a different pre-rendered stream when objects are turned on or off, the use of MPEG-4 is simulated.

To create all possible story line alternatives, seven different video streams were needed for this particular story. (Not only are different streams needed for storylines A, B and C, there are also further variants required for the different kinds of pets the girl can acquire on the way through the story.) The seven audio and video streams and the necessary EIT table events are multiplexed into a DVB transport stream and streamed to a set-top box capable of running DVB/MHP. On this terminal a small XLet manages the interaction and the switching between the different streams. The set-top box used for the presentation of this Toons version was a regular Philips Trimedia box.

While this version demonstrated the capabilities already available using current technologies, it also showed the limitations of an approach that is solely based on stream switching, mainly the fact that the number of required streams roughly doubles with every new intractable element in the storyline, but also that the viewer is always limited to choosing from pre-rendered appearances and has little capability of adding personal touches.

MPEG-4 variant

The main design criteria for the MPEG-4 version were:

1. Showcase features that can be achieved with MPEG-4, but which are impossible or difficult to

achieve with other standards.

2. Demonstrate that functionality available in other standards can also be achieved with MPEG-4.
3. Keep it short to allow demonstration together with other variants of Toons
4. Keep it fun and allow new kinds of interaction with the story line.

While MPEG-4 allows the presentation of alternative storylines by switching between multiple video streams, the main advantage of MPEG-4, compared to MPEG-2 based applications, is the capability to modify objects locally, at least in the context of Toons.

Since the selection of alternative storylines, the changing of moods and the addition of characters, all by the use of multiple video streams, have already been demonstrated in the other variants of the Toons application, it was decided to put the main focus of the MPEG-4 version on the ability to change objects locally.

There is also one alternative storyline based on stream switching, to show that doing this is also possible in MPEG-4. However, it is not the central feature of the application.

To allow local modification of specific story elements, the video sequences were rendered without some of the objects. These objects were added to the MPEG-4 scene tree as separate objects, which were animated using position interpolators.

To establish a clear spatial relationship of the objects, they were assigned to different 'layers'. This was achieved by moving the objects closer or farther in respect of the virtual camera position. While moving the objects from the original video plane, their size needed as well as their animation path parameters were adjusted. By keeping the objects in separate layers, a clear 'is-in-front-of' relationship between objects could be established, even if objects were rotated in respect to the camera. Keeping the objects in the original video plane would have led to objects in the background 'sticking' through foreground objects.

The personalization of the story was achieved primarily by modifying the textures of selected objects. While the original idea for replacing the texture of the girl was using either a drawing utility on a web site or pre-printed 'collectable cards', those methods could not be demonstrated well at a conference like IBC. For demonstration there, a different way for modifying objects and showcasing the capabilities of MPEG-4 was used.

A picture on the wall in one of the scenes was replaced by an image from a web cam positioned at the booth. The texture of the girl was replaced by using a scanner and 'colouring book'-type images of the girl (outline drawings in black pencil). Viewers could use pens and pencils to colour these images, which were then scanned in and used as textures for the girl shaped object in the MPEG-4 stream. This turned out to be a simple way of direct modification of object appearance in MPEG-4, which is also appealing to children (Figure 17). It is also a useful method to convey the possibilities and potential advantages of using MPEG-4 for personalizing TV content.

3.2.6 Tangible interaction devices

New interaction paradigms also imply the need for new interaction devices. This is especially true for applications aimed at children, like the Toons application. The typical interaction device for TV-like entertainment, the 'classic' infrared remote control, is often unsuitable for a number of reasons. The most obvious of these problems is that young children can't read (or at least can't read fast), so the usual menu-based interaction style ('Press 1 to take key, press 2 to leave room.') is not appropriate for the target group. While non-text based choices are possible (for example by painting doors red, green and yellow and choosing the door by pressing the corresponded button on the remote control), the number of choices are limited (there are only four coloured buttons on most remote controls), the inclusion of such visible markers can be obtrusive and disturb the 'look' of a scene, it's not always possible to choose a 'plausible' colour scheme (for a choice between a bat and a butterfly, there's no

'right' colour on the remote control for either character), and the changing semantics of a button during a programme can become confusing.

More important than those technical limitations are the limitations to the user experience of the broadcast. Effective storytelling requires a suspension of disbelief and an immersion into the story by the recipient. Pressing buttons on a remote control distracts the viewer and is an obstacle for creating an immersive viewing experience.

To provide such an experience, children need tangible interaction tools in their possession to interact with the onscreen objects and streams. These input devices need to provide feed forward and feedback in order to facilitate the interaction with the story. Feed forward can be obtained for example through light or sound in the input device to indicate what can be activated, what actions should be undertaken, and how actions can be achieved. This information must be broadcast by the broadcaster along with the story line. To enhance its effect, the story line should also supply information needed for the interaction, be it clues, voice-overs that tell the users that a decision point is at hand and similar things.

The interaction devices were designed such that they raised the curiosity of the children. Important goal was that the interaction devices were fun to use and that they stimulated the cognitive and physical development of children. A major reason for children to use technology is that they **enjoy** doing it [6]. To *keep children interested in using these technologies we need* to provide them with an '**experience**', that is, something that they voluntarily want to put effort in, something that provides them with a challenge while at the same time they possess the skills to do it. Not only achieving their goals should provide the experience, but also the activity of doing it should be rewarding. Two interaction devices were designed: *Stickysticks* and *Tunemein*.

The *Stickysticks* is a magnet table that challenges the fine motor skills of the children. By positioning magnetic sticks above certain magnets in the table the children can interact with e.g. broadcast content. Feedback and feed-forward is given through sound and magnetic force. Their curiosity is raised, as they do not know whether a magnet will attract or reject their magnetic stick. The *Tunemein* is based on the theremin-principle, a music instrument developed in the 1920's. It challenges the fine and gross motor skills of the children as they have to produce different tones (by moving their hands along the antenna) while at the same time adjusting the volume (by moving the hands towards and from the antenna). To raise the children's curiosity the tones change position along the antenna. Feedback and feed-forward is provided visually as well as auditory.

The positioning and combination of the magnets in the Stickysticks and the combination of a certain set of tones in the Tunemein correspond with the required input for a certain behaviour in the interactive TV program or in computer games. In this way, the toys can become carriers for elements in an interactive TV program. Figure 14 shows the devices. The use of the toy like device is shown in Figure 15.

The feedback provided by the input device should be immediate when actions are undertaken by the children. This can be in the input device itself, through sounds (*'click'* when a button is pressed) or light (an illuminated button that has been activated). In any case, information about the result of the undertaken action should always be immediately presented onscreen, so that the users know that their actions did have some effect. In our prototype, the moment the user chooses one of the doors, a scene will follow in which the chosen door starts opening.

Another interaction feedback device was demonstrated in connection with the Toons application at IBC2001, which was based on a PDA. Here the PDA was used as a bi-directional device, showing key frames from the scene currently visible on the TV and displaying the possible choices as graphical buttons (Figure 16). The advantages over a conventional remote control are obvious. The graphical buttons not only allow a direct association between the button and the function (e.g., a bat can be selected as a pet character by pressing the picture of the bat instead of requiring the user to mentally map key '1' to the bat for 'Press 1 to select the bat' kind of interfaces), but is also useable by children who haven't learned to read yet. The selection of alternative storylines, characters and moods can also be achieved without adding visual prompts to the programme visible on the TV screen, so that viewers, who don't want to participate actively, are not distracted by interaction cues on the TV.

Figure 14: Toons interaction devices:
Tunemein (left) and Stickysticks (right)

Figure 15: Child playing with the Tunemein

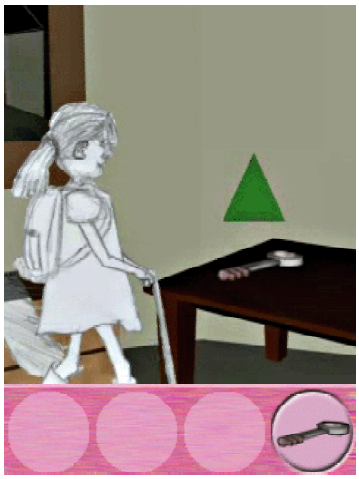

Figure 16: Screen of the PDA with buttons showing possible choices. In this case a key can be chosen.

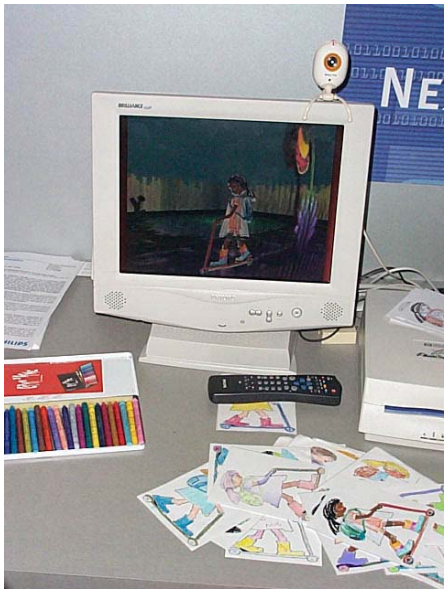

Figure 17: Modification of object appearance

4. Business framework and requirements

4.1. NexTV business framework

In evolving market spaces, with unknown new products, the development of new interactive application services can be enhanced if there are mechanisms to account for customers' feedback. In this volatile environment emerging business models are attained through systematic value-chain destruction and re-construction. Opportunities to integrate the value-chain appear through the identification of requirements for the application being developed. In contrast to other types of requirements, those that emerge during the application development process best capture the potential to generate innovative business models. The methodological approach employed during the application development process is therefore critical. Concerns for the final commercial viability of the application provide the incentive to adopt an approach that promotes the identification of emergent requirements.

The NexTV business framework is based on a flexible model structure suitable for consensus building and capable of aiding the different stakeholders in their quest for and discovery of, new business models. NexTV business framework is well suited to encompass an overall business framework analysis, and equally suited to the analysis of specific aspects of the business.

In the more basic instance of the NexTV business framework (Figure 18), seven actors and three conceptual layers of flow relationships are proposed. The actors are: Creator, Producer, Broadcaster, Delivery, Access, End-user and Interactivity Manager. The flow layers are: Supply (of physical product and/or application services), Payments and Rights. To complete the analysis of the NexTV business framework it is suggested to include (apart from the pure business perspective) the following perspectives:

- the hardware and software provisioning perspective,
- the mode of communication between actors perspective,
- the influence of standard committees perspective, and
- the policies, legal and regulation perspective.

The forward supply chain and the backward interactive chain are equally important in the NexTV business framework. The level of interactivity of each actor would vary depending on application service, technology adoption, standardisation level or target End-user group. For each actor (represented by a circle in Figure 18) the NexTV business framework foster the methodology for deriving the corresponding description of roles, interactions and transactions requirements for each application. At a deeper level of description, each actor is envisaged as a business entity and hence they have demand and supply characteristics as well as requirements and features associated to them. Note that only aspects of Supply and Payment layers were addressed in the context of this project.

Based on the NexTV framework described in Figure 18, the following sections discuss the interrelationships that exist between each of the seven stakeholders as well as their role and function during requirements definition, application development and business model description and implementation phases of the lifecycle development process.

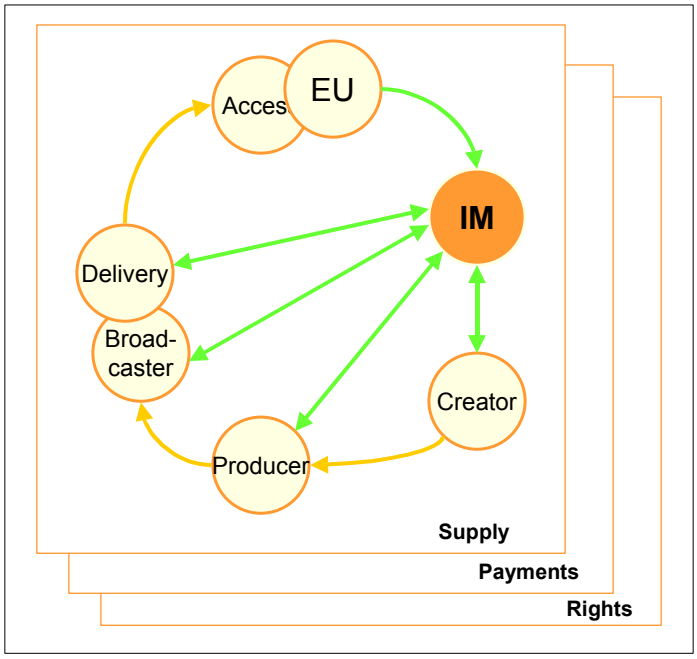

Figure 18: The NexTV business framework [WP1 D3].
(EU: End User, IM: Interactivity Manager)

4.1.1. Interactive application development: user-centric approach

When addressing the process of interactive application development, a possible classification of previously suggested approaches revolves around the level of awareness and mode of treatment of the uncertainty of requirements. Uncertainty arises from the fact that user needs and requirements are both too pervasive to be captured exhaustively and evolve over time. Four different types of approaches were identified as candidates to deal with underlying uncertainties on application requirements. At one extreme, waterfall approaches do not acknowledge uncertainty of requirements. Life cycle and incremental approaches acknowledge the presence of uncertainty and attempt to reconcile a set of proposed solutions with a static statement of requirements. Finally user-centric approaches appear to be the more appropriate in this case.

Three underlying principles of the user-centric approach render it the more appropriate to support the NexTV application developing process. First, users' involvement must be maximised. Second, standardised interfaces and re-usable components improve productivity and communication within the project. Third, firm and stable business concepts must address the uncertainty and volatility of human requirements. The first two principles are instrumental in the definition of the concept of 'user-centric loops' within the NexTV business framework. First, maximum involvement is achieved when the 'users' (actors) targeted by the user-centric approach are not limited to the end-users of the application, but include all parties interested in the application development process. Second, enhanced co-operation within the business/development team translates into the identification of subsets of actors associated to specific areas of development which can be worked on separately. Here, a user-centric loop arises when communication is established between the various actors involved in the same independent aspects of the application development process. Activities within user-centric loops are dynamic processes. During the initial stages of application development, loops may need to occur in a pre-defined sequential order. Some loops may be able to occur concurrently when the sufficient level of independence has been identified. However, it is advisable to realise that once started, all user-centric loops remain active throughout the application lifetime. This feature of the user-centric approach guarantees that new users, usage or technologies are incorporated within

the application as they emerge in response to new business solutions or requirements.

The user-centric approach ensures that volatile requirements are captured in a stable manner by the business model and associated scenarios. Furthermore, key application development issues can be addressed by actors/partners co-operating via on-going user-centric loops. Hence, communication between the economic or business realm and the technological realm is vital since a worthwhile application must reconcile the two domains.

4.2. Interactive service delivery costing and price analysis

Interactive TV services production can be considered as having two key components: Non-Interactive components, and interactive components for non-interactive and interactive output respectively. There are substantial implications in the differences between demands on the supply chain and costs that are associated with these two forms of output. On the one hand, non-interactive output involves the preparation of a service that is in effect a single unit. The costs of reproduction are effectively zero. If one person watches, or a whole nation, costs and the supply chain are largely unaffected. On the other hand, as the consumption of interactive output rises, so does the cost of provision. Otherwise the supply chain relationships are traditional. Due to its interactive nature the service may well require the close, not to say seamless integration of various suppliers. Suppliers may at the same time require production processes that range from those that individual Actors may support alone, to those requiring a full supply chain.

4.2.1. Costing methodologies

Generally, the purpose of the costing methodologies is to provide information that enables managers to make profitable decisions, anything that prevents them from doing this makes the product less competitive due to distorted decision-making. It is well known that different costing methodologies will provide different values. Hence the need for using more than one costing approaches has already been suggested in the literature. The idea is that the purpose of the information needs to be clear before looking at what methodology to apply. In WP1 Deliverable 4 two underlying methodologies were selected: i) the Top-down approach were an overall cost estimate for the process is derived from global properties of the product. The total cost (including common costs, or overheads) is then split up among the various components; and ii) the Bottom-up approach were each component of the process are separately estimated, and the results aggregated to produce an estimate for the overall product.

4.2.2. Bottom-up (or Incremental) costing

The Bottom-up approach suggests a least incremental cost value for a new service. It thus has a claim to efficiency that is not dependent on the choice of common cost allocation method. Supply chain efficiency is acquired however at the expense of existing services that will appear less profitable than the new service, thus potentially distorting decisions concerning relative services. Bottom-up cost modelling involves the construction of an engineering model of parts of the value chain. This implies the building up of a picture of the incremental resources required for a given level of output. Then it is considered that *new spending* has to be made in order to provide the new service. This new spending will become the reference point for the cost of the new service. For our purposes the analysis is composed of at least two steps: i) The supply of a non-interactive service, and ii) the addition of an Interactive Service.

Joint Costs (common resources used in the productive process) and Fully-Allocated Costs (the value chain split into separate Actors each just supplying this one service) are then computed and their ratio used as a proxy of true Interconnection Costs. The Bottom-up cost is useful for two purposes: i) to assess the degree of economies of scale and scope, and ii) to identify the costs under the cost-minimising deployment of technology.

4.2.3. Top-down costing

The Top-Down approach divides total projected costs of operation (i.e. Common Costs, Production and Input costs) into smaller parcels, identified with specific cost-centres and specific services. The Top-Down approach explicitly allocates a share of all costs to each service, rather than those costs that are associated with the addition of the new service. In this approach the incremental production costs are averaged to provide a smoothed incremental cost per unit of output. The Top-Down costing methodology relies in principle on taking company accounts and allocating costs to ever more precise areas of the business activity. It thus has the strengths and drawbacks of traditional cost accounting approaches.

4.2.4. Incremental Costs and Top-Down Costs

As mentioned above, one of the key requirements of a costing methodology is that the result is a clear guide for decision-making. In looking at incremental costs alone we fail to consider the relative costing values we assign to product lines. Hence, the use of any form of allocation can lead to allegations of cross subsidisation. What this means in practice is that one product will be cheaper than it might otherwise be (thus affecting competitors) and the other more expensive (affecting consumers). This is a typical problem faced by regulated industries. A commonly used means of testing the cross subsidisation of an allocation of fixed or common costs is the axiomatic approach. This approach identifies six intuitive axioms against which cost allocation can be assessed (cost sharing, rescaling, consistency, positivity, additivity and correlation). If the variable costs of services are additively separable between services, and no special set-up costs are required, then a closed form analytical expression exists. This expression is the same expression given by the Attributable Cost Method (ACM) proposed by the Fully Distributed Cost allocation.

4.2.5. Price strategy

It is well known that the type of cost methodology used affects the derived cost figure and their prices, and that different costing methodologies could provide a means of assessing how cost values are being skewed by the methodology used. The NexTV value chain involves costs that are partly of the form commonly addressed in public utility literature (i.e. high sunk costs and very low marginal costs), and partly a more standard cost structure in which marginal costs are non-negligible. Hence, the pricing policy adopted for the service will need to meet the requirements of this form of composite cost structure, and the preferences of End-Users, rather than any one specific method.

Note also that the impact of interactivity on costs, and how they differ both between stakeholders, and between non-interactive and interactive production, and the scaling of costs with consumption and its impact on the type of pricing was also addressed. The fact that costs scale differentially leads to a consideration of differential pricing. The economic efficiency of differential pricing is well established. The notion that pricing may be more personalised than a simple one price fits all is intuitively appropriate to a service that aims to provide a personalised service.

Dynamic and product line pricing models were also investigated. Dynamic models develop price strategies that optimise profits over a number of periods. This is of especial value if it is likely to be some time before a service is profitable. Product line pricing deals with some of the issues we address through the Top-down costing approach, in that the distinction between product lines can be made on a number of bases, most of which are strategic and subjective.

4.2.6 Remarks on costs and price discrimination

The efficiency arguments for price discrimination are strong, both on profit and welfare grounds. Also due to the characteristics of the NexTV service itself it was observed that costs scale differently for each Actor depending on the proportion of interactive output it produces. Moreover, there is a possibility of NexTV services requiring investment that ensures that there is a significant period before profitability is achieved. This suggests that a combination of subscription and marginal cost pricing are appropriate, and the level of investment makes dynamic pricing a better choice than single period pricing.

In order to see how some of these costs and potential market power issues look in practice, several scenarios for each of the two NexTV services were addressed in WP1 Deliverable 4. The aim being to show how at a given level of consumption costs are distributed and how we might suggest pricing strategy based on this information.

The scenarios developed in WP1 Deliverable 4 aimed at investigating two important characteristics of cost and price strategy: the impact of costing methodologies, and the impact of supply chain form (e.g. including the IM) on costs. The underlying results indicated the need for flexibility of costing methodology in the supply chain, and the range of outcomes that can be achieved. These results also provided the basis for more complete models.

4.3. Crucial aspects

4.3.1. Technology, content, connectivity and consumers

Compelling content sells technology – this is the basis for industry rallying cries of 'content is king'. The alternatives 'connectivity is king'; 'technology is king' or 'consumer is king' have also been touted as arguments for attention to be placed upon different aspects of an overall media system. However, logic dictates that it is surely the combination of each facet, the final product arising from the symbiosis of content, technology, human *and* telecommunications networking, that works and serves as the basis of successful media products. Hence, a more insightful view perhaps comes under the auspices of the notion 'context is king'. This pertains to building, managing and negotiating the *relevancy* of functional and operational attributes of a technology or media system, maintaining a focus neither obsessed with technology, nor consumers, but rather use and usage of product.

There is also a delicate balance to be drawn in the creation of an innovation between it maintaining differentiation in the market and ensuring interoperability and compatibility with technologies pre-existing in the marketplace. The history of media technologies abounds with examples of failed products and their software, or products that only partially achieved results. While the ultimate arbitrators of a product's success is the consumer, it is crucial to open and maintain links to others working in the field, whilst guarding the product unique selling points. The way this has been successfully done is by adhering to standards, whilst also lending added value functionally and in terms of features set.

4.3.2 Usability

These are important questions that must be asked, as they should be at the forefront in questions regarding design as well as marketing strategies. A rather scathing report of the state of trials in the early 1990s (from WP1 Deliverable 5) highlighted the inadequacies of the systems to provide a useful and usable bundle of interactive services. Technologies are not only built to perform functions they must be built to perform uses. Aside from the regular usability problems, there are also issues of trust and privacy that affect people's decisions to e.g. buy on-line. This situation may lead to the regressive situation of people not buying anything, due to negative experiences in dealing with one particular vendor, or even simply experiencing usability difficulties associated to a particular element of the interactive service offering (e.g. transport infrastructure service degradation).

The occasions and instances of use, utility and the realisation of usability and value are intrinsically linked and intertwine in the creation and evolution of a new technology design. This is especially true for communication system design, as they place so much reliance upon users and their experience of using, in their adoption and success. Shifting perspective to the user whilst considering the general technological trends of personalisation, mobility, increased choice industry must consider the usability of interfaces and services as a holistic and multidimensional experience.

4.3.3. Communities

Virtual communities are socio-economic business models. Online communities are focused online social gatherings, were communication is multidirectional, with users responsible for providing material as well as consuming information. Repeated interaction reinforces the social features of community, builds trust and creates sense of belonging. Community builders face several critical challenges. As

always, there is the challenge of gaining attention and building traffic to the site. This is doubly important for communities trying to reach a critical mass of members. The first step in igniting and increasing cycle is stimulating trial by potential members. Established communities can also encounter difficulties. Member collaboration and content sharing can be undermined in several ways. Focus can be lost as communities change and grow. Content generation can break down if members feel unappreciated or apathetic. Incentives that work in smaller groups can fall as the community blossom.

4.3.4. The use of incentives to increase community loyalty

Loyalty in a business context has been used to describe a customer's willingness to continue patronising a firm over the long term, purchasing and using its goods and services on a repeated and preferably exclusive basis. It also includes voluntary recommending the firm's product to friends. There is evidence that effective means to attracting loyalty may be achievable with holistic incentive programmes, which would cover the complete cycle of the target customer activities. Flexible schemes of "cash equivalents" rewards is an attractive proposition in contrast to the non-monetary rewards that rely heavily on the attractiveness of the offer to specific consumer (customer) groups. Hence, the nature and flexibility of incentive schemes may be the key success factor when introducing a new service. Rewards should be targeted to strengthen the value proposition or change customer behaviour. In this arena, there is tremendous potential in offering horizontal or vertical co-operation through incentive programs. Horizontal co-operation could develop, for example, around different consumer life stages. Families with children could find value in a retailer offering novel services such as free babysitting in a centralised crèche facility a few times a month, which would allow parents to have free evenings. Vertical incentive programs could be built up around some habits and clusters of needs and services. Examples here include travel or home buying items such as insurance, loans, car rental are some examples, often cluster around these consumption activities.

4.3.5. Revenue streams

A variety of revenue-based business approaches have flourished on interactive media. Flexibility has allow experimentation, with companies trying to match revenue needs to capabilities of the medium. The major split between www business models has fallen into four categories: advertising, retail, intermediaries, and services. In Deliverable 5 the following models were discussed in more depth: Content sponsorship, Retail alliance, Banner advertising, Prospect fees and Sales commission. All of these revenue streams are potentially viable within the NexTV technological setting. Figure 19 summarises the suggested payment approaches evolution within the NexTV service offering.

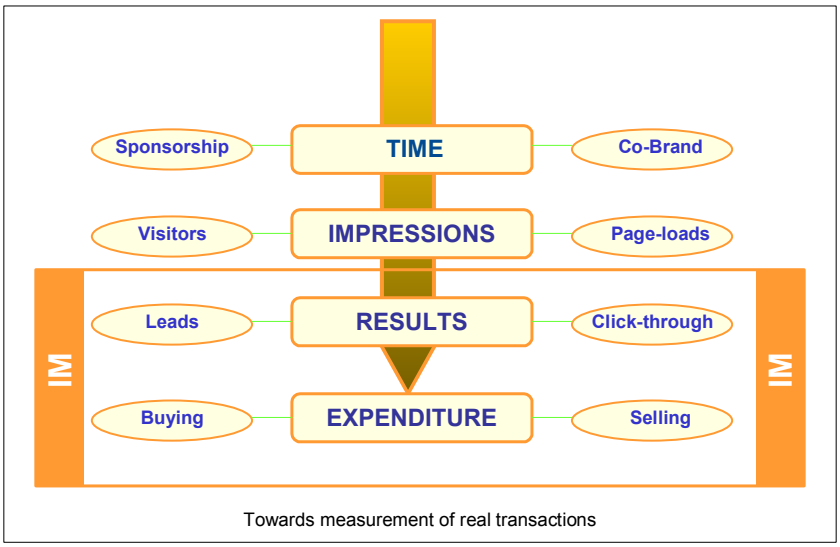

Figure 19: Possible payment approaches [WP1 D5].

Note that these approaches differ in the way they are measured. Sponsorships and co-branding arrangements are negotiated for a fixed length of time. Banner advertisements are managed based on the total number of impressions. Actions drive the third level. Sites can be paid based on the leads they generate, the visits that occur, or the number of downloads performed. Finally, the payment can be based on the amount of sales. Moving from sponsorship to banner advertisements to prospect fees to commission is an increase in both accountability and risk of being paid.

4.3.6. Payment systems

While micro-payments, smart cards, and electronic (online) billing each play an interesting and important role in e-commerce, the top three *credit card* companies handle over 98% of all purchases made on the www (form Deliverable 5). Contrast this figure with transaction outside the Internet, where only about 20% of all purchases are made with credit cards, and it's obvious that credit cards are the driving force behind online business-to-consumer transactions. A major reason for credit cards' popularity online - in the US - is that consumer protection laws issued by the Federal Reserve Board limit a customer's liabilities for the fraudulent use of her/his card to $50. If the site does have problem in accepting credit cards, person-to-person payment services have popped up. With these services, which eliminate the need to mail a paper check, the customer in effect e-mail money using a credit card or bank account.

4.3.7 Cross media synergies example (SMS – text messages)

It is common today – even for children – to posses and use mobile phones. Usually these are prepaid, or in certain countries account limits can be placed. Text messages (short text messages or SMS) are very common in younger user groups and parental allowances permit use within an account limit. This is an example on how to provide a cross-media experience that encompasses SMS and real-time interactive TV application services.

4.3.8 Electronic Programme Guide (EPG), portal evolution and the Interactivity Manager (IM)

Original Portals have evolved on the www from providing a list of vendor and information sites, to

having the potential to personalise content and vendor sites for individual users. Furthermore, many of the major www portals are now moving to provide for mobile access. Unfortunately, one of the lags regarding crossing media with portals is the management of new services, as mobile and broadcasting organisations lack the experience in the arena of content and service provision.

Future generation of portals in association with a particular set of IM functionalities (Deliverable 5) may be the only place where the mass or general audience exists, and the place where more eclectic offers and chance purchasing opportunities can be made. In effect, this contradicts the contextual mode of product and service provision, but does relate to the way in which a newspaper reader happens upon an advertisement for a novel item they would not otherwise search for.

4.3.9. The Interactivity Manager (IM) and Customer Relationship Management (CRM) systems

In a fast evolving market space, each time customers make contact using whatever media, the customer profile (not necessary the customer identity) should be easily recognisable and the appropriate response action taken. For example, every customer who interact with the NexTV applications would register to “MyProfile”. In the first encounter only a limited amount of questions would be asked, but “MyProfile” could be updated at any time and the corresponding profile continuously enhanced with customers’ emergent needs. The role of the IM could then be to operate and maintain the “MyProfile” features. At all times the customers should be able to access the information kept by the IM and modify/deleted them if he/she wishes. Other confidential service that the customers could delegate to the IM, is the handling of monetary transactions on their behalf. In this case the customer could choose different payment mechanisms, e.g., credit card and/or online banking by means of a “MySaldo” service. The role of the IM would then be to operate and maintain “MySaldo”. With a “MySaldo” service the customer could have access to more sophisticated ways of using credit and managing funds when purchasing services or goods.

Many opportunities to cross-sell and co-operate in different sectors are visible in a NexTV business environment, and hence it makes good business sense to build up multi-companies and multi-purposes customer relationship management (CRM) systems and incentives schemes to cross use different services and goods.

4.3.10. Fragmentation

With almost total penetration, the audience and market for TV-centric products potentially straddles all age groups and demographics. There is vague segmentation if one considers that games consoles players will be predominately young, whereas protracted and daytime TV viewers will be the unemployed, housewives and the elderly. However, consumer research points to the growing complexity of consumer lifestyles and identities, and to the waning influence of demographic characteristics. People no longer act in strict accordance with age or gender, and there is also evidence that people are not thinking or behaving within the parameters of their assumed 'segment'. This has important implications, not only for companies' segmentation of consumers, but also for their strategic building of brands and customer relationships. Hence, the notion of “prime time” advertising slots, where “guaranteed” audience numbers could be predicated disappear. In their place comes the opportunity to advertise to very particularised audience niches. The NexTV IM business entity could play an important role here in terms of managing services locally relevant (by means of e.g. the “MyProfile” service). For example, by allowing narrow-casting specific information and offers in accordance with an individual’s geographical, financial, life stage, or any other specific personal dimension increases relevancy. This in turn increases the likelihood of a sale.

4.3.11 Unorthodox marketing

Sharing information has a long history beginning with hand-written codex’s and printed books. These transformed society by allowing users to preserve and transmit information. File swapping is hardly new, as people have been doing it peer-to-peer for some time now via e-mail. However, emergent services such as storage sites for personal and group photo albums emphasises a new facility and customer behaviour. The notoriety of such services has not come about through the sharing of personally produced content, but rather commercially produced content. In the consumer-to-consumer

interaction there has been much discussion about the notion of “unorthodox, viral or indirect” marketing, which suggests activities that are not traditional media marketing, but rather passed on a peer-to-peer level at a relatively fast rate. The Napster type means of delivery, having much in common with the “seeding” notion of software and technology diffusion, provided the opportunity for consumers to express their interest. It is also clear that owners of digital material, which in the future may include proactive members of an interactive audience, will need to protect their digitised goods without inhibiting their trade. However, as recent examples show, ideal levels of protection do not come easily.

4.3.12 Market impact

A well-conceived interactive multimedia delivery business will only succeed if it can reliably provide high and consistent quality of content, service and transmission. The interested stakeholders will come to a point where they must evaluate projects based on synergistic opportunity and financial feasibility. Obviously, the management and operation of an alliance of companies which will be tied strategically, technically (i.e. sharing a system, all be it, for different purposes) and economically will be of great importance. For instance, if the communications network is plagued with ‘outages’ then this will affect consumer expectations, as much as poor delivery times for products or services ordered using a portal or EPG. Hence, the formation of strong alignment across distribution chains both horizontally as well as vertically will be of strategic importance. It is in this market arena that the NexTV IM could have a big impact in the management and operation of the business.

A successful deployment of new interactive application services can only arise from addressing a combination of distinct problem areas. These include issues regarding technology, human, social and economic factors, organisation, consumer markets and regulatory and legal issues. WP1 deliverables have addressed important issues on most of these areas. And in all the relevant discussions an overarching concept - the *Interactivity Manager* (IM) – played an instrumental role which allowed to analyse disparate facets such as transactional, operational, and interface layers as a holistic phenomena.

5. Feasibility of key technology

For the implementation of NexTV's demonstration scenarios the partners planned to use MHP and MPEG-4 technology. This technology was in the process of being standardised during the project and first implementations became available. NexTV intended to be one of the first to use these implementations in the interactive TV environment.

Valuable experience has been built up on the status and (im)possibilities of the technology and tools used for the implementation. These experiences and the feasibility of using the tools for the NexTV applications are described in this chapter.

5.1. MPEG-4 feasibility issues

MPEG-4 (ISO 14496) has been chosen as the primary standard for implementing the NexTV applications. MPEG-4 surpasses other standards in this application area, and inherently allows the combination of two-dimensional (2D) and three-dimensional (3D) objects in a scene, allowing an integration of video and augmenting information that would not be possible otherwise.

Specifically the Toons application would not have been possible with earlier standards. This application allows the modification of object that appear to the viewer to be part of the video stream. MPEG-4 allowed us to separate specific objects from the actual video stream, running in the background, and synchronize the movement of these objects with the video. Since the scene structure of MPEG-4 allows the easy modification and replacement of objects in the scene, objects could arbitrarily be changed and appear to the viewer to change in the video according to individual taste.

With earlier standards, like MPEG-2, the only way to provide an individual viewing experience for each viewer would have been to render a specific MPEG-2 stream for each viewer, which is not feasible due to bandwidth and other considerations. While a standard like VRML would have allowed individual modification of the scene trees, it would also have required that all of the rendering takes place on the client side, which allows only very simple scenes, since complex scenes can't be rendered in real-time with typical customer equipment.

MPEG-4 allowed us to use the best features of pre-rendered video (high-quality, appealing, professional look) and local customisation by keeping the pre-rendered video as a background video and extracting only those elements that needed to be rendered locally.

Although MPEG-4, as a standard, enables new types of applications, there are some problems arising in actually creating applications using MPEG-4 today. While most of these are more a concern of the implementations of the standard than of the standard itself and will be less relevant as more MPEG-4 based products become available, these inconveniences might slow down the acceptance of MPEG-4 in the early phases.

5.1.1. MPEG-4 standard concerns

Full screen video

Many applications will feature a full screen video running in the background of MPEG-4 based menus and animations. Unfortunately the standard does not provide a video object that runs as a fixed background video directly. While the effect itself can be achieved by proper BIFS handling, a specific object type would be useful.

Since the effect itself can be achieved by other means in MPEG-4 it seems unlikely that a specific object for full screen video will be standardized.

Profiles

Since MPEG-4 is a very rich standard, most current implementations do not cover the full scope of the standard. While profiles for specific areas have been and will be defined, most current implementation

still have to be evaluated on a feature-by-feature basis. An early definition of typical profiles in the standard would have made the classification of implementations easier.

Profiles for MPEG-4 are emerging right now, most notably the ISMA 1.0 specification, which has been released in the first week of October 2001. While it probably would have given the development of MPEG-4 players more focus, if such a profile had been available earlier, the new profile is still a very welcome addition today.

5.1.2. Player-specific concerns

No MPEG-4 player on the market implements the full range of the MPEG-4 standard. In addition, all existing players have very specific strengths and weaknesses. It is often necessary to use a specific player to fulfil the potentials of an application. For the NexTV project the SoNG player has been selected, since it contains a powerful implementation of the VRML-based parts of the MPEG-4 standard.

There are, however, a number of limitations of this particular player.

Limited video functionality

The implementations of H.263 and MPEG-4 video, which are built into the player, are limited in size. While video sizes of a quarter PAL resolution are sufficient for textures on small objects, they are not sufficient for full screen video presentation. Decoding of other types of video is not implemented directly in the SoNG player, but is handled by using the Windows MediaPlayer routines. While this allows access to a wide range of video formats, it limits the capability of interaction between the objects in the MPEG-4 scene graph and the videos. Synchronization between BIFS animated objects and video is very difficult. The use of external video player routines introduces a non-predictable 'loading time'. Since there is no indication when the video actually started running, tight synchronization between two videos or a video and BIFS animated objects is almost impossible. It has to be noted that this 'synchronization uncertainty' is usually only about a third of a second. While this does not cause any undue problems with most applications, even for time critical objects like subtitles, it did cause some problems for the Toons application, where a frame-by-frame synchronization between the background video and the animated objects in the foreground was desired.

New players will most likely have a tighter integration of video and non-video elements. The new player by the Heinrich-Hertz-Institute (HHI) that was shown at IFA 2001 seems to be a step in that direction. It is to be expected that better players will be available in less than two years.

Limited video size

In the early phases of the project, it was intended to use one large video (roughly 2000 by 1500 pixel) and a PAL sized view port. While the standard supports applications like these, there was no player available that could actually handle such video sizes at 25 frames per second or more.

Unless HDTV makes a strong impact in the marketplace, it seems unlikely that this will change in the near future. Most video players are targeted at PAL and wide-screen PAL resolutions, while players capable of 1920x1088 resolutions will remain rare for some time.

5.1.3. Authoring concerns

Shaped video

One of the interesting features of MPEG-4 is the capability to use shaped videos. For the Toons application, it would have been a welcome addition to use shaped video for various elements, but due to a lack of available authoring tools for shaped video, we had to restrict ourselves to using polygons and shape animation to simulate the effects. Availability of a simple authoring tool for creating shaped video from animated or existing colour-keyed video would have allowed enhancing the range of capabilities significantly.

While useable tools for creating shaped MPEG-4 videos are still not widely available, they are

currently being developed and will probably reach the market soon. For example, one tool for creating such videos was demonstrated at the SoNG presentation on the IST booth at the IBC 2001 conference.

5.2. MHP feasibility issues

In the context of the feasibility assessment of the MHP platform for the NexTV goals the outcome is positive from the point of view of availability, applicability and robustness. With respect to the required flexibility and interactivity the conclusion is negative from the point of view from expected possible integration with MPEG-4 technology. See with this respect the expected evolution of the integration of the two technologies at the end of paragraph 5.3.

To improve the feasibility of the Java technology for the MHP standard, SUN Microsystems Inc, the owner of the technology, partner in NexTV, and an active player in the development of the MHP standard, considered the initial plans of the project very important. The aim of the improvement activity was defined as follows: "Since the end user platform will make substantive use of Java Virtual Machine technology, there will be an analysis of the existing virtual machine technology to test those components for robustness, memory usage and real time performance, along with the parallel realization of some components of the control tasks of a set-top box/digital TV architecture in Java."

Derived from this aim a number of (major) problem areas have been identified in close corporation with SUN Microsystems Inc.:

- Improvement of the performance of the VM
- Garbage collection methodology and performance gain
- Extensive use of semaphores

These problems have been addressed in the continuing development of the VM technology. Of course not all of them have been solved completely due to various reasons. The current available technology is, however, sufficient for its intended purpose. As most of these problems have been solved by SUN Microsystems Inc., with support and evaluation of the NexTV project team, there was room and capacity to address different issues related to the MHP and Java domain.

In the timeframe of the NexTV project a few new problems in MHP development became important for practical use of the platform when performing real and realistic application scenarios. The first one is the so-called application life cycle model. In the first release of MHP (Version 1.0) there is no notion of allocation life cycle management. An application is started at the initialisation of the terminal (either from the boot process or by the down load mechanism) and is stopped by either switching of or resetting the terminal. Allowing a user to switch between applications or even to allow the concurrent execution of multiple applications is impossible. The project has put a lot of efforts, together with partners in the MHP group and in close relation with SUN Microsystems Inc. to improve this situation. As a result a complete application life cycle management is available in the current version of MHP (Version 1.1).

Another important missing aspect in the MHP standard is the possibility to apply smart card technology in the terminal to support all kind of application and/or business models. The security provided by the smart card technology allows the use of electronic payment and to store private information of the user in the terminal. The project has made significant contributions to the development of a smart card frame work in the Java operating environment of the MHP platform as a robust, reliable and resource constrained solution. The result of this activity is an adopted version of the embedded Open Card Framework (eOCF) that has successfully been promoted to the MHP group and has been fully adapted in the current version of the MHP standard (version 1.1). The current application scenario of the NexTV project however does not make use yet of these functionalities as these (business) related aspects are not within the scope of the applications being developed.

5.3. Migration of MPEG-4 towards the broadcast domain

MPEG-4 is an object-based audio-visual representation model with hyper-linking and interaction capabilities supporting a variety of both natural and synthetic content. MPEG-4 can be used to enable object-based interactive digital television. The spectator in such equipment views a scene that is composed from objects (audio, video, graphics, text etc.). MPEG-4 content is made of many elementary streams. One stream is the scene description (BIFS) stream that provides the composition information. Another stream is the object description stream that describes the other streams. Additional streams convey objects to the scene. An MPEG-4 scene can by dynamic. I.e., the composition information may change in time, either through update commands that are conveyed in the scene description stream, or as result of interaction between objects. A change in one object may create an event that can be routed to other object(s). Interactivity in MPEG-4 scenes is achieved by using sensor objects, i.e. objects that create events when the viewer operates on the terminal with a remote control or a pointing device. This kind of interactivity is dubbed “local interactivity”, which means that the viewer interacts with the content, and not necessarily with a remote server, as is known from the Internet.

DVB-MHP on the other hand defines a specification for interactive set-top boxes that support downloaded applications (allowing a medium level of interactivity) as well as media content. The basic content that the application is dealing with is however the streamed (MPEG-2) content in the DVB channel. All additional content representations that are allowed within the specification are however not structured with respect to their interrelation (dependency and timing). As such its up to the application developer to take care of these important aspects of the interactive application and the end result is very depending on the all the other elements in the delivery chain as the multiplexing, de-multiplexing, decoding, rendering and composition.

Java is an essential part of the MHP standard; an MHP device always includes a Java Virtual Machine (JVM). A Java VM runs Java byte-code. Byte-code can be compared with machine instructions for a regular processor like a Pentium. Byte-code can be interpreted, or dynamically compiled, or a mixture of the two. The VM abstracts from the underlying (real-time) operating system and hardware. This makes Java the key enabler for interoperability. The JVM offers excellent functionality to dynamically download applications into the VM. The VM was designed for the dynamic downloading of code. There are no linking problems. Java, by now, offers excellent support for security trough a byte-code verifier, absence of pointers and a sandbox model. Furthermore there is support for automatic garbage collection, it is object-oriented and allows for easy programming supporting multi-threading. There is a lot of tool support.

Currently the maturity of MPEG-4 and DVB-MHP are not on an equal level and this has important consequences for the applicability (of course also for a potential combination) in the consumer-oriented domain.

DVB-MHP (for its first version) has been frozen, form a technical point of view, more than two years ago. At the 1999 IFA in Berlin, interoperability between different equipment providers, different service providers and different application developers has been demonstrated. This was a proof of concept and a feasibility assessment with respect to the maturity of the technology and its implementability. Since that time a lot of effort has been spend on the improvement of the technology, development of tools but even more important on the development of test suits to guarantee the interoperability of applications and the conformance of terminals to the standard. This is a crucial aspect before wide scale deployment in the consumer domain can start.

The MPEG-4 standard on the other hand is in fact a (large) set of coding standards with a very sophisticated control layer. Parts of the standard are being deployed in the Internet domain but no selection (in MPEG-4 terms profile and level) has yet been selected for broadcast domain applications. As a result of this the interoperability testing of applications and the conformance testing of MPEG-4 decoder implementations for the consumer domain has not been addressed at all.

For this reason the NexTV project has chosen for a mixed solution in the demonstrators that run on a consumer terminal, the set-top box. The application is developed in the studio based on MPEG-4 technology but is delivered to the terminal in a number of concurrent MPEG-2 streams containing the composed MPEG-4 objects of the different application paths. On the terminal the user, under control of a DVB-MHP application, makes selections that influence the scene development resulting in the

switching between the different MPEG-2 streams representing MPEG-4 object compositions.

The aim of the integration, after the maturity aspects have been solved, of MPEG-4 technology into the DVB-MHP standard (or, logical extension of the DVB-MHP standard with MPEG-4) is to achieve the useful (for the end-user point of view) combination of the Broadcast application domain with the interactivity of the Internet domain in a controlled fashion. From the user perspective it provides the ability to consume and interact with rich (multimedia) content. For the content provider, distributor and service provider it offers the framework of an international standard with al its benefits like interoperability, conformance testing and availability (op both authoring tools, players and content).

The combination of DVB and MPEG-4 provides the ability to utilise very flexible and interactive application possibilities for the interactive broadcast domain. The possibilities provided by the MPEG-2 standard to transport MPEG-4 content over an MPEG-2 Transport Stream or via a separate link using an IP connection enables the smooth (backwards compatible) and gradual introduction of advanced interactive content into the broadcast domain.

6. Conclusion

In the course of the project, the development of the applications and the implementation of demonstrators became the driving forces in the project. The lead was in Work package 3 with a group of cooperating partners for each of the two applications that were developed. These applications explored two different approaches to interactive TV and covered the spectrum from delivery to consumption. In the myGuide application users have portals for bundling existing services and programs, they can get additional information for arbitrary TV programs and they can use bi-directional communication to access a virtual shopping centre. In the Toons application users can interact with content within programs, they can customize the content, configure the looks, and add personal content. MyGuide bundles services while Toons is a specific new service. This approach to application development proved to be very useful to identify problems with current platforms and tools that hamper application development and tune down ambitions. With regard to the service side, i.e., myGuide, we encountered many problems with regard to compatibility, interoperability, and performance of systems. With regard to the receiver side, i.e., Toons, we found that the functionality of current set-top box architectures, the MHP platform and the available MPEG-4 players are very limited with regard to end-user intervention with the actual content. We had to adopt different strategies for implementation of our concepts while remaining within the theoretical realm of the standards. With the NexTV demonstrators, which are the products of these adopted strategies and work a-rounds, we showed new convincing concepts for interactive TV. These demonstrators were presented at IBC2001 and IST2001 where we communicated the central role for the end-user in the NexTV project with the subtitle 'from technology to experience'. The NexTV applications showed the need for extending the DVB-MHP standard with MPEG-4 technology to achieve a useful combination of the Broadcast application domain with the interactivity of the Internet domain for the end-user.

The user-centred approach was also central to the development of the business framework, which provides a flexible structure for deriving business models that can cope with volatile and uncertain requirements by using different scenarios. Central to the business models is a new entity, the Interaction Manager (IM), which handles the relationships and transactions, including user profiles, between all the entities in the value chain. A cost model was developed to compare costing methodologies and their affect on price in the value chain. Two operational scenarios for determining cost and price level strategies for the myGuide and the Toons applications were developed in which different levels of interactivity for the end-users could be accounted for. Also, the interactive service market characteristics and usability aspects were investigated.

For the assessment and evaluation of the applications we had to take another strategy than foreseen in the initial Description of Work. We used a user-centred approach for the development of the applications. This implies that the requirements for the application are being derived in an iterative process. The demonstrators at the end of the project are basically the result of the first iteration. They are now ready for evaluation with users to generate feedback. This is still an exploratory phase in which only heuristic and qualitative methods can be used. Even this is complex as we are dealing with many confounding variables. Methodologies are hardly available for the interactive TV domain. The evaluation for technical feasibility encountered problems of a different character as they concentrated mainly on the performance and functionality of individual components of the platform, for example MPEG-4 players and production tools.

In sum, the NexTV project achieved a turn-around in application development from a technology-driven to a user-driven approach. New concepts for interactive TV in which the end-user can intervene in the program and alter the content were created. The project showed the need for extending the DVB-MHP standard with MPEG-4 technology to achieve real end-user benefits for interactive TV.

7. References

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8. Project Output

8.1. List of project deliverables

Sequence Number	Title
WP0D1	Project Description
WP0D2	Project Handbook
WP1D1	Preliminary Business Framework and choice of applications
WP1D2	Requirements for the selected application and its user interface
WP2D1	Required and prioritised improvements for the JVM
WP4D1	First intermediate report on assessment and evaluation of the project
WP1D3	Set of business roles, requirements and interactions
WP2D2	NexTV Terminal Rel. 1
WP2D3	Server application Rel. 1
WP2D4	Streaming engine Rel. 1
WP2D5	Production tool set Rel. 1
WP4D2	Second intermediate report on assessment and evaluation of the project
WP3D1	Applications (to be chosen) version 1
WP1D4	Cost structure and Price level strategy
WP3D2+ WP3D3	Application final version (former WP3D2 application to be chosen version 2 and WP3 D3 Specific Terminal Application)
WP2D2	NexTV Terminal Rel. 2
WP2D3	Server application Rel. 2
WP2D4	Streaming engine Rel. 2
WP2D5	Production tool set Rel. 2
WP1D5	Business assessment and set of Recommendations
WP4D4+ WP4D5	Assessment and technical feasibility of NexTV implementations
WP0D4	Report on Standardization Activity

8.2. List of public demonstrations

Date	Event or Exhibition	Nature of Demonstration
28-30 May 2000	ISCAS 2000, Geneva. TILAB	WP2: Pre- Alpha version of MPEG-4/2: Client receiving from satellite. Satellite server (intermediate freq.) AIC-I application (Interactive News) V1
8-12 Sept 2000	IBC 2000,Amsterdam New Technology Campus TILAB	WP2: Alpha V1 – MPEG-4/2 Client, Integrated injector of MPEG-4 on 2. AIC-I application (Interactive News) V2
8-12 Sept 2000	IBC 2000, Amsterdam. Optibase	WP2: Alpha V1 - MPEG-4 Client, Streamer, Server
8-12 Sept 2000	IBC 2000, Amsterdam NOB	Segmented news application at the MPEG-4 campus on the Philips booth using NOB news content coded in MPEG-4.
23-27 Oct 2000	MPEG meeting, La Baule	Demonstration of NexTV´s 3D-player for presenting local content
10-12 Oct 2000	Streaming Media, London Optibase	WP2: Alpha V1 - MPEG-4 Client, Streamer, Server.
Feb. 2001	Optibase Channel meeting	Technology demo of Real time encoding & streaming of ISO MPEG4 over IP multicast
Apr 2001	NAB, Las Vegas, USA Optibase	Technology demo of encoding and streaming ISO MPEG4, with interactivity (moving text and jpeg)
30 May–02 Jun 2001	KOBA 2001, Korea International Broadcast, Audio & Lighting Equipments Show, ETRI	Etri demonstrated the ATSC implementation of the myGuide demo
Jun 2001	Streaming Media West, USA Optibase	Technology demo Real time encoding and streaming of MPEG4 over IP Multicast. Demo with WizRT of MPEG4 encoding and streaming broadcast quality material over the internet including 3D graphics & animations
Jun 2001	MPEG4 workshop, USA Optibase	Demo with WizRT of MPEG4 encoding and streaming broadcast quality material over the internet including 3D graphics & animations.
Jun 2001	CommunicAsia, Singapore ETRI	Technology demo of real time encoding and streaming of MPEG4 over IP Multicast
13-18 Sept 2001	International Broadcast Convention, IBC2001, Amsterdam, NL	ISTV (Information Society Technologies Village)

		Joint demonstration of seven projects of the E3 IST clusters: Interfaces & Enhanced Services and Signal Processing & Mixed Reality.
13-18 Sept 2001	International Broadcast Convention, IBC2001, Amsterdam, NL	Demonstration of the NexTV concepts for enhanced and interactive TV, myGuide and TOONS applications.
3-5 Dec 2001	IST2001, Düsseldorf, D	Demonstration of the NexTV concepts for enhanced and interactive TV, myGuide and TOONS applications.

8.3. List of published papers and presentations

Barria, J., (2001) NexTV Business Framework and Applications. Interactive Distributed Multimedia Systems (IDMS 2001), ACM SIGCOMM/ACM SIGMM, 4-7 Sept 2001.

Barria, J. (2001) Chasing End-User Utility in Interactive Service Delivery. Research Policy, Elsevier Science, 16 Oct 2001

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Sangwoo. "Personalized and Interactive broadcasting system", Workshop on Personalization in Future TV, Sonthofen, Germany, July 13-14, 2001

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Sept 30 –Oct 5, 2001.

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9. Consortium partners

Philips Electronics Nederland B.V.

Philips Research
Prof. Holstlaan 4
5656 AA Eindhoven, NL

Contact person:
Maddy D. Janse (Project Leader)
E-mail: maddy.janse@philips.com
Phone: +31 40 27 42863
Fax: +31 40 27 44918

The Imperial College of Science Technology and Medicine

Electrical and Electronic Engineering Department
Exhibition Road
SW7 2AZ London, UK

Contact person:
Javier Barria
E-Mail: j.barria@ic.ak.co
Phone: +44 171 594 6275
Fax: +44-171 5946302

T-Nova Deutsche Telekom Innovationsgesellschaft GmbH

Multimodal Applications and Systems, BERKOM
Am Kavalleriesand 3
64307 Darmstadt, D

Contact person:
Jens Johann
Email: jens.johann@t-systems.de
Phone: +49 6151 838330
Fax: +49 6151 834842

Fraunhofer Gesellschaft (former GMD)

Institute for Open Communication Systems (FOKUS)
Kaiserin-Augusta-Allee 31
10589 Berlin, D

Contact person:
Angela Scheller
Email: Scheller@fokus.gmd.de
Phone: +49 30 3463 7214
Fax: +49 30 3463 8214

Optibase Ltd.

7 Shenkar Street
46120 Hertzeliya Pituach, IL

Contact person:
Zvi Lifshitz
Email: zvil@csi.com, zvil@optibase.com
Phone: +972 2 679 4788
Fax: +972 2 679 4789

Telecom Italia Lab

TILAB
Via Reiss Romoli, 274
10148 Torino, IT

Contact person:
Gianluca De Petris
Email: Gianluca.DePetris@TILAB.COM
Phone: +39 011 2286109
Fax: +39 011 2286299

Sony Service Centre Europe N.V

Network Solutions and Services Europe
Sint-Stevens-Woluwestraat 55
1130 Brussel, B

Contact person:
Gert Copejans
Email: gert.copejans@sonycom.com
Phone: +32 2 724 86 81
Fax: +32 2 724 86 88

Koninklijke KPN NV

KPN Research
St. Paulusstraat 4
2260 AK Leidschendam, NL

Contact person:
Dick van Smirren
Email: D.vanSmirren@kpn.com
Phone: +31 70 446 0052
Fax: +31 70 446 3477

Sun Microsystems Inc.
901 San Antonio Road
Palo Alto, CA 94030-4900, US

Contact person:
Gerard Fernando
Email: Gerard.fernando@sun.com

Phone: +1-650 7866373
Fax: +1-650 7866445

Electronics and Telecommunications Research Institute – ETRI

Radio & Broadcasting Technology Laboratory
161 Kajong-Dong, Yusong-Gu
305-350 Taejon, KR

Contact person:
Chieteuk Ahn
Email: Ahnc@etri.re.kr
Phone: +82 42 860 6141
Fax: +82 42 860 6141

Nederlands Omroepproductie Bedrijf

NOB - Innovatie
Sumatralaan 45
1200 JB Hilversum, NL

Contact person:
Peter Mulder
Email: peter.mulder@nob.nl
Phone: +31 35 677 4614
Fax: +31 35 677 4201

France Telecom

R&D
38-40 Rue du Général Leclerc
92 794 Issy Moulineaux, F

Contact person:
Olivier Avaro
Email: olivier.avaro@francetelecom.com
Phone: +33 1 45294097
Fax: +33 2 99123704

Appendix A

EPG for an ATSC environment: Scenario of the application

The project partner ETRI focused its work on the development of the platform and tools to apply technologies for interactive broadcasting based on ATSC techniques. The application scenario, which was developed, is described below.
One of the available programs, for example 'Miss Korea 99' or the historical drama 'King Wang-Gun', which are encoded in the MPEG-2 format, is decoded and displayed on an interactive terminal based on ATSC.

Figure 1: Main program

Pressing the 'M' button on the control will display the 'Additional Information Menu' on the upper-left side. This menu provides information which is not directly related to the program shown at the moment. Figure 4 shows the 'Additional Information', which is not related to the main program.
The 'Additional Information' consists of an EPG, news, stock ticker, weather, film, plays, commercials and e-mail information. Depending on the viewers preferences, you can select one menu item to see more information. The data of the 'Additional Information' is encapsulated into protocols based on ATSC.

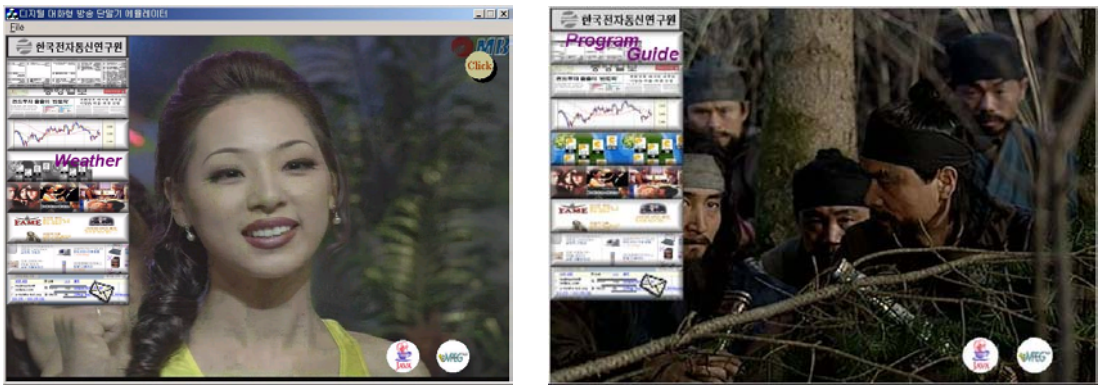

Figure 2: Additional Information

If the viewer, for example, select the news button or commercial button, he will find the latest news or commercial information. Figure 5 and 6 illustrate news and commercial information shown as an overlay. In addition, the user can request more detailed information on the subject using the back channel accessed through the icon at the bottom-right of the picture.

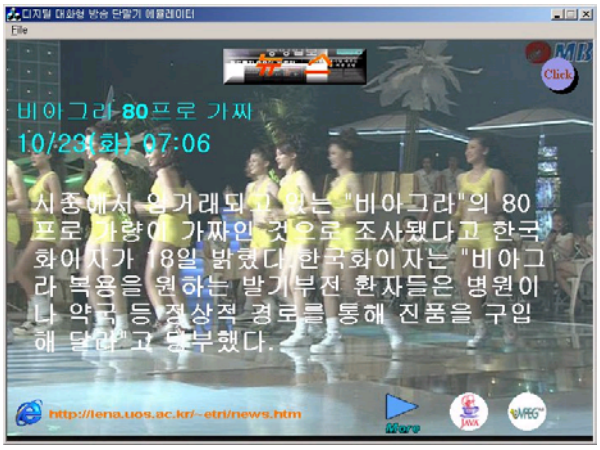

Figure 3: An example of a news overlay

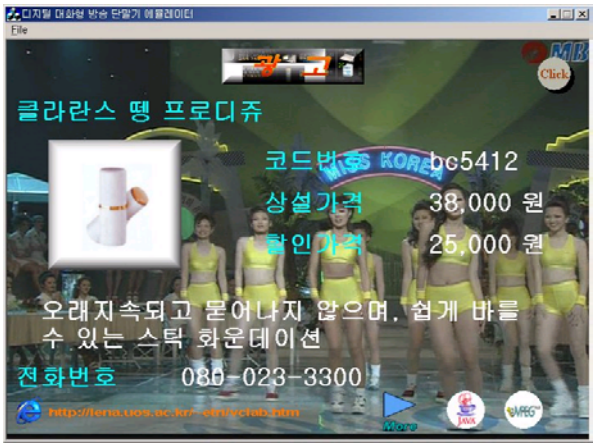

Figure 4: An example of a commercial information overlay

If the user selects the EPG button in figure 5, the 'Personalised Guide' will appear at the bottom screen of the screen, similar to implementation of the corresponding feature in myGuide.
The 'Personalised Guide' consists of genre selection, user selection, last selection and table of recommendated programs. Program selection and searching is achieved using the control device. In addition, the interactive TV also recommends programs based on a database with a list of programs that the user has frequently watched in the past. Of course, if there are tele-shopping programs that the user has occasionally watched, these will also be recommended.
The 'Personalized Guide' has been integrated into interactive terminal based on ATSC in the form of HTML. Figure 7 shows the personalized EPG with the MPEG-2 main program running in a small window. The 'Personalized Guide' consists of viewer setting, program schedule, program searching and program genre. Each of those information can be achieved by clicking on the corresponding button. The viewer setting is used to provide a viewer's specified profile such as channel preference. The program schedule provides the list of programs for each channel with time (figure 8). Clicking on each program in the table leads to a summary of the program. The program searching helps to find a program in terms of channel, genre and date (figure 9). In addition, the interactive TV also recommends favourite programs based on a database with a list of programs that the viewer has frequently watched in the past. Of course, if there are tele-shopping programs that the viewer has occasionally watched, these are also recommended. Figure 10 shows an example of a recommended program.

Figure 5: Personalized Guide

Figure 6: Program list

Figure 7: Program searching

Figure 8: Program proposal

Additional information related to the main program is transmitted as MPEG-4. MPEG-4 supports interactive functionality for the program. If MPEG-4 data is parsed and ready for composition and display, you will see the bright yellow 'trigger button' on upper-right side as shown in figures 3 to 6.
Clicking on this trigger button on the upper right side of the screen, an additional interactive service will be started, which is implemented with the MPEG-4 technologies. The menu icons for the additional information include former contest winners, individual profiles and portrait photos as shown in figure 12.
If one of the icons is selected, the user will see the detailed information.

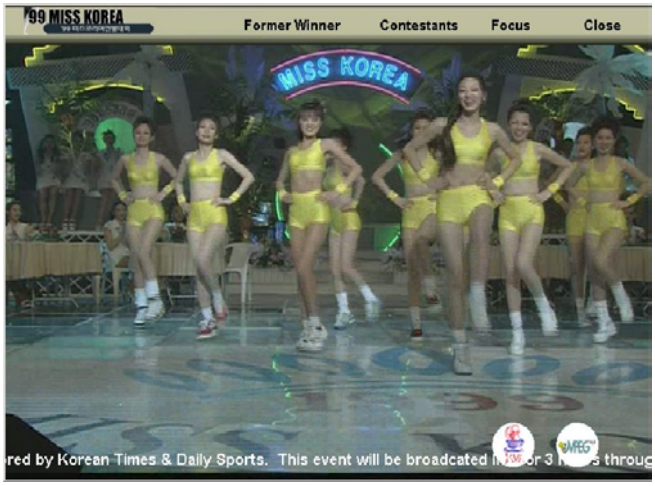

Figure 9: MPEG-4 additional information menu

For example, when the user clicks on the 'former contest winners' or 'individual profiles' icon, he will see the detailed information on each of the contest winners or individual profiles as an MPEG-4 scene. Clicking the arrows at the bottom of the small window, allows the scrolling to previous contest winners. The small window can also be moved on the screen.

Figure 10: Winners of former contest

Clicking the “Java” trigger button on bottom right side of the screen, the user can also select additional interactive entertainment (a guessing game), which is provided as an Xlet. Xlets are based on DASE, especially the procedural application part. (Figure 13).

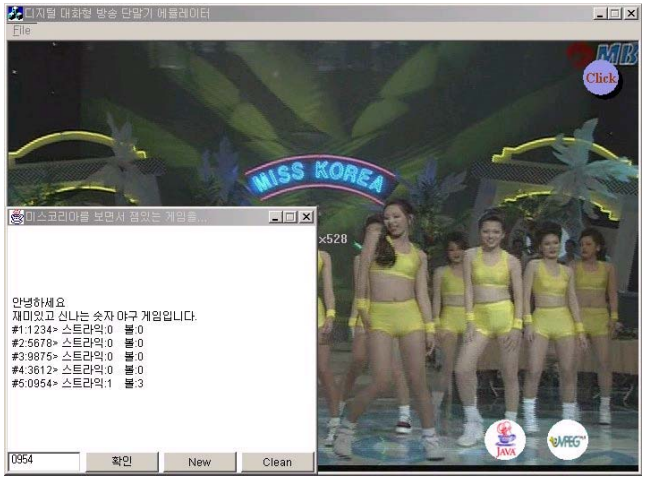

Figure 11: : Interactive entertainment (guessing game)

Clicking on the “MPEG” trigger button on the bottom right side of the screen, the user can also enjoy another interactive service, which is implemented using MPEG-7 technologies. It provides the user with information about the program that is currently airing and helps searching what the user prefers to watch. (The implementation of this MPEG-7 application is still in progress.)
All additional information is provided as XML or MPEG-4/7. MPEG-4 contents are synchronous with the main program, while XML contents are not. ETRI is implementing a moving picture application as additional information related to the main program with MPEG-4 technology. Additional applications, such as the Xlet, are currently not time-shared (of course, they could be made time-shared to run in parallel with a quiz-show, for example). It will provide additional enjoyment for users by providing real time gaming while users are watching TV.