Home Media Server content management

Andrew Tokmakoff and Harry van Vliet

Telematica Instituut
P.O. Box 589
Enschede 7500 AN
Netherlands
Phone: +31 (0)53-4850461
Fax: +31 (0)53-4850400
Email: [tokmakoff, vanvliet]@telin.nl

ABSTRACT

With the advent of set-top boxes, the convergence of TV (broadcasting) and PC (Internet) is set to enter the home environment. Currently, a great deal of activity is occurring in developing standards (TV-Anytime Forum) and devices (TiVo) for local storage on Home Media Servers (HMS). These devices lie at the heart of convergence of the triad: communications/networks - content/media - computing/software. Besides massive storage capacity and being a communications 'gateway', the home media server is characterised by the ability to handle metadata and software that provides an easy to use on-screen interface and intelligent search/content handling facilities.

In this paper, we describe a research prototype HMS that is being developed within the GigaCE[1] project at the Telematica Instituut[2]. Our prototype demonstrates advanced search and retrieval (video browsing), adaptive user profiling and an innovative 3D component of the Electronic Program Guide (EPG) which represents online presence. We discuss the use of MPEG-7 for representing metadata, the use of MPEG-21 working draft standards for content identification, description and rights expression, and the use of HMS peer-to-peer content distribution approaches. Finally, we outline explorative user behaviour experiments that aim to investigate the effectiveness of the prototype HMS during development.

Keywords: Home Media Server, Personal Digital Recorder, Personalisation, Electronic Program Guide, Content Distribution, Video Browsing, T-Commerce

1. INTRODUCTION

In what the French call 'the ballet of the electrons', the worlds of Information and Communications Technology (ICT), Internet and broadcast television are coming together, stimulated by the digital revolution and with the mission to conquer the home environment. Currently the most prominent weapons in this campaign are the set-top box and the Personal Digital Recorder (PDR) [1]. Positioned as a 'link' between the home network and the networks (both the broadcast network and Internet) that are 'out there', it represents the dream of the broadcast, entertainment and telecom industry: the 'connected' home.

Set-top boxes have already been with us for many years. The first generation of set-top boxes were capable of only receiving and unscrambling analogue transmissions and displaying the results on the TV set. But set-top boxes are quickly evolving from simple gateways for de-scrambling television signals towards powerful devices for interactive services. A recent step toward this has been the introduction of the PDR, a consumer device that includes high capacity disk storage. Commercial examples include TiVo, ReplayTV and UltimateTV. PDRs give consumers the opportunity to 'time-shift'; i.e. to watch what they want, when they want. More importantly, such PDRs come with specific services for personalisation: like an electronic program guide that shows (filtered) information and gives suggestions on possibly interesting content. The addition of a back channel provides a mechanism to allow for commercial services including

[1] The GigaCE (GigaPort Content Engineering) project (gigace.telin.nl) is a knowledge acquisition project focussing on content engineering, which is part of the GigaPort project (www.gigaport.nl). GigaPort prepares the Dutch industry and knowledge institutes for Next Generation Internet. GigaPort is a joint initiative of industry, higher education, research institutes and the Dutch government.
[2] http://www.telin.nl

storage and profile management. In our opinion, it will be this demand for new services like archiving/storage, interactivity, personalisation, et cetera that will push the set top box, PDR, or a similar 'box', from a simple interface for de-scrambling signals or a super-VCR for time-shifting towards a central server device within the home environment. A comprehensive overview of the convergence between TV and the next generation Internet is presented in [2].

Such a device, the Home Media Server (HMS), has communications as its main characteristic. In a world where media convergence creates a unified environment where content is available from a variety of sources, and where technology is erasing the boundaries between televisions, telephones and computers, the HMS is a central device for the consumer to control his communications, whether it be telephone, Internet narrowcasting or television broadcasting. Many services will evolve support consumers as they struggle to manage this information glut, since we all now live in a world where there is so much content and so little time.

Within the GigaCE project at the Telematica Instituut we are developing a research prototype of a HMS that implements services that go beyond the current PDRs but which can already be found in other contexts, such as the Internet or mobile telephony. For instance, we investigate 'presence' functionality in a TV environment, so users can tell who else of their peers are watching a specific program. We also investigate annotating TV-content for indexing and search and retrieval purposes, along with peer-to-peer content distribution approaches. In this paper we address the framework within which this prototype is being developed by describing the use of MPEG-7 for representing metadata and the use of MPEG-21 for content identification, description and rights management. Furthermore we will elaborate on the specific services which will be part of our own prototype.

2. BASIC FUNCTIONALITY

If we take the current set-top boxes and PDRs as a starting point, we can say that the offered functionality is basic indeed. Through the set-top box we get (conditional) access to analogue and digital broadcast data, which means more channels with (sometimes) better picture and sound quality. By way of the PDR we can 'timeshift': watch what we want when we want. This is something that we have heard before, when the VCR was introduced. Since then, the VCR has developed into both a ubiquitous and marginal device, which is primarily used to play pre-recorded (children's) video tapes [3].

Of course the digital format and the instant access of the hard-disk give the PDR some profound extensions to basic VCR functionality such as:

- if joining a (live) program halfway, the system must be able to capture the content from the beginning.
- continue recording a program even when it may jump channels.
- record a program/advertisement on a basis of now, when it is on for next 'x' shows, all episodes, just the highlights, record the next trailer, etcetera. Repeats or the same transmission on other channels are resolved.
- pause a live event and return to it later. Related to this, be able to fast forward back to real time or to skip forward through index points.
- instant fast-forward and rewind (the latter also in live programs).
- simultaneous record and playback.

However, we do not believe that it will be this "super-VCR" functionality that will be the driving force for consumers to buy a new device. What can distinguish the PDR from the VCR, though, is its usability. How many VCR-displays don't display 'set clock', because the consumer has given up on programming the device? The PDR instead can offer an easy interface to available content by means of an Electronic Program Guide (EPG). Consumers can search through the EPG and record shows by interacting with the EPG grid. It is easy ('clicking') and reminds us of using a regular printed TV guide. Moreover, if personalisation is incorporated, all kinds of user support services can be envisioned, for instance:

- build your own TV guide– so there are fewer things to look at. This can be based on genre, time, channel, date, sub-genre specific, or any combination thereof, or on already pre-filtered content that the user profile has created.
- make use of channels of pre-filtered content, third parties offering 'best-of' from all content providers they cover, or pre-formatted EPGs based on viewer preferences.
- highlight (e.g. use of colours) of favourite programs in the program overview.

However, even with these enhancements the PDR still has a limited 'range'. In a HMS environment we must envision an "open" environment, in which (digital) content is widely available from different sources, communication is ubiquitous and devices exchange information and content transparently.

In such an environment, new questions arise and new service opportunities become possible. An example of this is integrated search facilities for content and an integrated presentation of the search results (see section 5). Currently, broadcast content, the Internet and the home network all have their own way of allowing the user search for specific content and their own ways of presenting the search results. For broadcasting this is the Electronic Program Guide (EPG), for the Internet these are search engines and directory services, and for locally stored digital content this is a PC-like file system interface. If we truly want a unified 'portal', an integration of these facilities should be pursued [4]. Another example is the portability of user profiles, so they are no longer tied to the home but instead, to the actual person. We will address these new services opportunities and their possible implementation in the following sections.

3. PROFILING AND PERSONALISATION

As mentioned above, one of the most promising aspects of the HMS is its capability to provide a personalised user experience. In a personalised information system, information is tailored towards the user in a given situation and context. The overall effect is to give the user an optimal individual experience, which targets the specific goals of the user. Examples of such systems are personalised newspapers, personalised online store catalogues, publication recommendation systems, personalised TV guides, and personalised lectures.

In order to personalise such services, there is a need to collect user information and build a user-specific profile. This profile forms the basis for personalised services, which utilise the user-specific profile to adjust their system behaviour. The "Content Handling and Usage" element of the MPEG-21 Multimedia Framework Standardisation work [5] involves identifying approaches for creating, modifying and managing User Profiles. In addition, the ability to interchange profiles between applications and systems is an important goal.

3.1. Profile creation and maintenance

We are developing a profile format, based on the TV-Anytime Metadata Model [6] which allows multiple applications to use a single profile. The profile consists of both generic user information and also application-specific elements. For example, the user's preferred language is a standard element which can be used by all applications that utilise the profile. In contrast, the HMS is an application which adds unique aspects to the profile (such as the user's favourite TV movie genre) which is possibly not of interest to every application using the profile (e.g. an mp3/cd player). We expect that MPEG-7 will be useful in this work on developing portable and interoperable profiles.

An important point is that a user profile is (ideally) created once, usable in a specific context and inter-changeable between different contexts and application domains. It is also important to be able to consolidate multiple profiles created by different applications into a single portable profile. This is currently an area of further work in the project.

When designing a personalised information system it is important to choose the most appropriate method for profile initialisation and maintenance.

- *Initialisation:* When a personalised information system is used for the first time, it has no knowledge about the interests of its users and thus, must obtain information from the user to allow a user profile to be initialised. There are several possibilities for the initialisation of a user profile. With explicit creation, the user creates the profile explicitly (e.g. by adding keywords to the profile). It is also possible that the user is questioned by the system and based on the answers, the user's interests are deduced. Another option is to let the user select one or more pre-defined profiles to start with, which function like a template for the user profile. Some systems allow implicit profile creation where the user is able to start using the system and the system builds a user profile purely by analysis of the users actions.
- *Maintenance:* It is important for personalised information systems to keep user information up-to-date, especially for systems that are used more than once. For systems that are only used once it is not necessary to store the user interests, as users will not use that same system again (e.g. a museum information system for tourists inside a museum). Keeping information about the user up-to-date can be done in two ways: using feedback from the user or by allowing the user to manually update the user profile. Concerning the former, there are two main ways that feedback

can be used to maintain a user profile: by analysing the usage behaviour, which is called implicit feedback, and by using explicit relevance feedback. In our prototype HMS, a logging component gathers and stores user actions for implicit feedback while a Profile Maintenance process analyses this information and performs the necessary updates of the user profile. Explicit feedback is gathered directly from the user via the Presentation (user interface) and processed by a Profile Maintenance process.

Our prototype HMS system will use a combination of the above approaches; the option to select a pre-defined profile, the ability to explicitly modify user profiles and most importantly, automatic profile generation based on user actions.

3.2. Personalisation of system functionality

The prototype HMS uses a centralised personalisation component which is responsible for providing personalisation services to other functional components in the system. For example, the Presentation aspect of the User Interface can make use of the personalisation component to alter the way it presents information to the user. This can be thought of as an adaptive user interface, much in the same style as the adaptive "Start menu" introduced into the Windows 2000[3] user interface. For each of the functionalities in the system which requires personalisation, a new sub-component is required. These sub-components include the Search, Presentation and of course, Content Suggestion.

3.3. Approaches to Personalisation

Personalisation, which is the adaptation of a system to the user, can be applied to many different aspects of the HMS. It can be used to adjust the user interface by selecting and presenting only specific information to the user and even translating a piece of information into the user's preferred language. All automatic personalisation is based on the knowledge the system has about the user which is stored in the user profile. In the demonstrator we are developing, personalisation component acts as an advisor for other components. E.g. the search component uses the personalisation component to rank search results and to modify the search strings sent to search engines, based upon the user's profile. It is also used to help the system make decisions on what up-coming content in the EPG the user may find interesting based upon previous viewing. Based upon the advice of the personalisation component, the system can make a decision whether to record the program item or not.

Using a personalisation component as an abstraction layer between the different processes that need personalisation advice and the user profile has to following advantages:

- The different processes do not need to have knowledge about the structure of the user profile;
- Personalisation techniques can be implemented once and be easily re-used for advising different components;
- New personalisation techniques can be introduced, without having to update all components that require personalisation advice.

Depending on the type of personalisation (user interface adjust or personalised selection of information), there are different types of personalisation techniques to do this. Because our focus lies on the personalised selection of information, the different techniques available will be discussed here briefly:

- *Category selection:* With this technique all information is segmented into categories. The user profile of a user contains the categories the user is interested in. In the personalised selection process, only information that belongs to the categories the user is interested in is retrieved. e.g. My Yahoo! (http://my.yahoo.com).
- *Query adjustment:* With query adjustment the search query (which is either explicitly created by the user when querying or implicitly created when browsing or filtering) for a database or search engine is changed based on the knowledge the system has about the different influencing factors.
- *Information filtering:* This is the process in which a system filters a vast amount of information and only delivers or recommends information that it considers relevant or interesting to the specific user. The key aspect of information filtering is that the system bases its recommendation on the content and its knowledge about the interests of the user.
- *Social filtering:* These systems (also called collaborative filtering) search for users with similar interests and recommends items those users liked. Instead of computing the similarity between items (content) as in information filtering, the system computes the similarity between users. How others liked a piece of information is based on how

[3] http://www.microsoft.com/windows2000

they rated these items (explicitly and/or implicitly). An advantage of social filtering is that it works on all media types, as no content analysis is needed.

- *Collaborative information filtering:* This approach combines techniques from social filtering (finding similar users) and techniques from information filtering (filtering based on content). Hirsh, et.al. [7] argue that the combination of information filtering and collaborative methods are better than each of them separately.

3.4. Demonstration : Portable and Interoperable Profiles

A small demonstrator that illustrates some of our Profiling & Personalisation ideas is under development and consists of the following:

- Initially, we define and initialise a user profile based upon simple user feedback (a web-based application). This profile is stored in the HMS itself.
- Using this profile, the HMS provides simple content recommendations based upon the user profile.
- The profile may be transferred from the HMS to a PDA and back (the PDA is only used as portable storage device). While on the PDA, the profile is used for other applications (such as an mp3 player) and modified as necessary.
- When profile is returned to the HMS, the roaming profile is "re-integrated" into the HMS's local profile, taking into account changes in the profile on the PDA.
- The profile is then shown to be interoperable between devices and applications by showing a "before and after" comparison of content suggestion. Before the profile is modified, a set of content is suggested whereas after the profile returns, a different set of content is suggested.

An extension of this scenario envisions a group of friends that are having a gathering and who decide to watch some content together. In order to come to a simple and fast decision on what to watch, each group member's personal profile (conveniently located on their PDA) is transmitted to the host HMS system, at which point the system recommends TV programs for them to watch together.

4. STORAGE OF CONTENT AND METADATA

With large amounts of multimedia content being captured by the HMS, there is a need for a storage component that efficiently manages the storage and subsequent retrieval of content and its associated metadata. The ability to save content to external storage (ie CD-RW) is an important new functionality that extends the usefulness of the PDR, but must also respect the associated Digital Item (DI) Intellectual Property (IP) rights.

We adopt the "fridge" and "freezer" model in which content that is to be used in the short-term is stored in a so-called fridge, whereas content that is to be kept for the long-term is stored in a freezer. Content in the fridge is accessible at all times since it is located within the PDR, whereas freezer content is located on external storage. In both cases, however, in order to manage vast quantities of stored content, it must be easy to search through and retrieve relevant pieces of content. This, of course, requires the use of metadata, which provides information on the content in a searchable form.

4.1. MPEG-7 and Content Metadata

Metadata is useful for two different kinds of processes: automatic search and automatic personalization of information. Also there are two types of metadata: content identification metadata, which describes (multimedia) documents as a whole, and content based metadata, which gives access to subparts of (multimedia) documents such as an occurrence of a specific keyword. Hence, metadata contribute to reusability and accessibility of content.

MPEG-7, officially named the "Multimedia Content Description Interface", is an emerging standard for content-based indexing for digital libraries. It provides standardisation of multimedia content descriptions. The elements standardised by MPEG-7 allow a range of applications as broad as possible. Since only the descriptor types are standardised, it is generally applicable for all types of content. Thus, all sorts of audio-visual material may be disclosed by the use of MPEG-7, including still pictures, graphics, 3D models, audio, speech, video, and information on how these elements are combined in a multimedia presentation (scenarios, composition information).

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