Multichannel Distribution for Universal Multimedia Access in Home Media Gateways

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Abstract. Today, people collect their personal multimedia content on home media servers. In addition to consuming their content on TV sets, people are using mobile multimedia players, PCs and even mobile phones. Since those terminals have various capabilities, it is necessary to adapt the content to a more device specific version. For audio, video, and graphics scalable codecs exist which realize this goal. For multimedia presentations no such scalable coding is available. This paper introduces a multichannel distribution system in home media gateways, this implies that a multimedia presentation can to be created once, and consumed on every possible terminal. The introduced multichannel distribution system is realized by combining MPEG-21 technology with existing device specific presentation languages. This results in a device agnostic Digital Item which can be transformed into a device specific presentation. The resulted presentation takes advantage of the full potential of a terminal.

1 Introduction

Today, people are using home media servers as their storage for personal multimedia content. By doing this, they create a repository containing all of their favorite songs, pictures, movies, and any combination of them. Due to this augmenting use of personal media, a demand for new ways of consuming media became apparent. This resulted in the development of many new versatile products. Creators of mobile devices are currently building hardware platforms powerful enough to bring the experience of a multimedia application to mobile terminals. Given the capabilities of these new devices, end-users are becoming more and more able to access their personal multimedia content anywhere, at any time.

Accessing multimedia anywhere, anytime, and on any device, is generally known as Universal Multimedia Access (UMA) [1], [2]. To realize this in a home environment, it is necessary to change a home media server into a home media gateway on which content is stored once and consumed using various devices in various circumstances, as presented in Fig. 1. To realize this goal, research is going on in different fields [3], [4] allowing the realization of UMA. This research handles about the multimedia content, not about the presentation. It proposes a scalable presentation format that can be used in a multichannel distribution system.

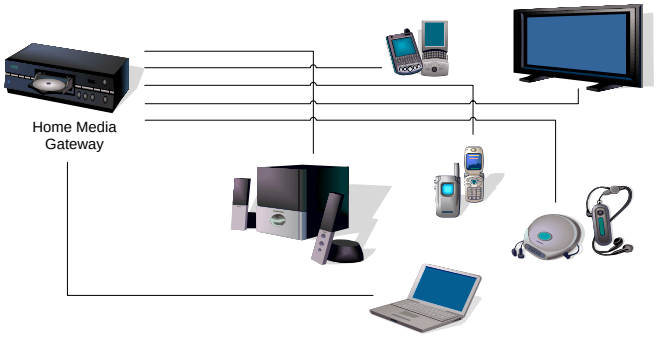

Fig. 1. Universal Multimedia Access for Home Media Gateways

2 Two approaches to multichannel distribution

When multimedia is provided to a home media gateway nowadays, it is typically designed for one target class of devices. This makes it hard for consumers to use their content on the variety of multimedia devices they typically own. To be able to access the content on their devices, they often need to store several versions of the same content with each version targeted at a different device. In a UMA framework, the ultimate goal is to create, and therefore store, once and afterwards use the content everywhere.

For audio and video data, this problem is solved by the creation of scalable content which can be consumed at different bitrates and resolutions. For multimedia presentations, which are usually a composition of audio, video, text, and graphics, no such scalable coding is available. However, there are at least two possible approaches to realize the UMA goal for multimedia presentations. A first approach is to define one high-level, device agnostic, multimedia presentation and to derive new multimedia presentations for each class of devices from this high-level presentation. The major drawback of this high-level approach is the fact that the full potential of a presentation language, which is usually designed for one specific target device, can not be used. The reason behind this is the fact that in this high-level approach, the multimedia presentation is declared at a device-independent level and transformed to a device-specific level. Because this translation needs to be possible to any device specific language, it is not possible to include device specific information in the high-level presentation. Therefore, it is not possible to make optimal use of device specific functionalities, which results in a generic presentation which might be unacceptable to the end-user.

The second approach, which we will discuss in the rest of this paper, will separate multimedia data (i.e., metadata about audio, video, text, and graphics) from the presentation structure. With this approach we will reuse the multimedia data to the largest extend possible while still being able to optimally use the capabilities of device specific presentation languages. Although this will require new device specific presentation information for each class of devices, it allows the reuse of the

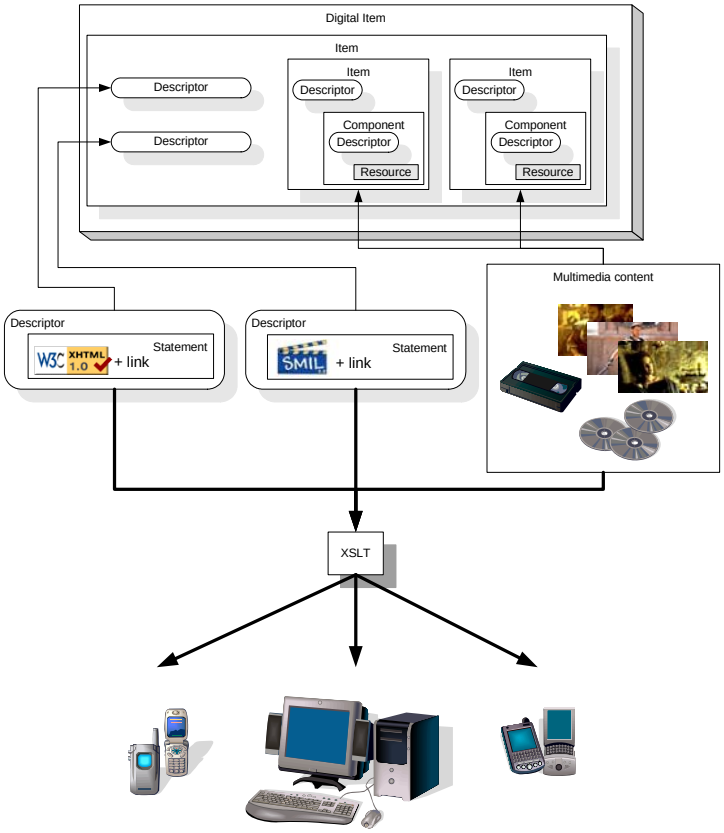

Fig. 2. Multichannel distribution in home media gateways using MPEG-21 DIs

multimedia data used in the presentation. While this does not completely realize the true UMA philosophy, it is a first step closer to realizing UMA by allowing the multimedia data to be stored once and to be used in the different presentations for each class of devices.

3 Architecture

The main idea behind the second approach is that it is possible to separate multimedia content from its presentation description. To be able to do this, it is necessary to have a declaration format which can describe and organize multimedia content. In MPEG-21 [5], which tries to realize the 'big picture' in the multimedia production, delivery, and consumption chain, such a format is provided in the Digital Item Declaration (DID) [6]. The DID introduces the concept of Digital Items (DIs) which are defined as structured digital objects, with a standard representation, identification,

and metadata within the MPEG-21 framework. In this paper, we use the DIs as storage format for multimedia content in a home media gateway. Because of the flexibility of DIs, it is possible to include both the presentation information and the multimedia data. For the multichannel distribution, both types of data are included in separate sections of the DI. When publishing for a specific class of devices, the relevant presentation data is combined with the multimedia content into a multimedia presentation which uses the full potential of the target device. Fig. 2 gives an overview of the architecture used in this approach when realizing UMA in home media gateways.

At the top of Fig. 2, there is an example DI containing two different presentations. The first one is XHTML-based, the second one is SMIL-based. In addition, the DI contains the different elements of the multimedia presentation. The presentation information contained in the Descriptors of the DI is expressed in an enhanced version of XHTML, SMIL, or any XML-based language. The enhancement is the inclusion of a link between an XML-based language and the MPEG-21 DI. How this enhancement is realized is discussed in Sect. 4.

To translate the generic DI structure into a device-specific presentation, an Extensible Stylesheet Language Transformations (XSLT) processor is used. This XSLT processor uses several XSLT stylesheets to combine the information in the presentation with the actual multimedia content. To realize this it resolves the links in the presentation and replaces it by the actual multimedia content. By using XSLT, it is possible to do the translation of the generic DI into a device-specific presentation either at the home media gateway or at the device. The only requirement for this architecture is that an XSLT processor is installed on the device (gateway or end-user terminal) which is performing the translation using the DI and the stylesheets attached to the DI. For example, it is possible to consume DIs with a standard web browser after translating it into HTML using the presentation data and the XSLT stylesheets.

4 Linking XML-based Presentation Languages to Digital Items

To be able to use information stored in a DI within existing XML-based presentation languages, it is necessary to extend presentation languages in such a way that they support linking between them and the DI. This can be realized by the introduction of a new XML element, called `Link`, which is a placeholder pointing to the actual multimedia content in the DI. There are two possible situations in which linking can be required. The first is a `Link` pointing to content that needs to be placed in an attribute. The second is a `Link` pointing to content that needs to be placed between tags. Fig. 3 gives an example of both situations when linking XHTML to MPEG-21 DIs. At the top of the figure, a DI containing the multimedia content is presented. At the bottom of the figure, the two possible situations that require linking are shown: a link for an attribute and a link for data between elements. When a link for an attribute is needed, a placeholder (i.e., ‘mpeg21-replacement’) is placed in the concerned attribute. This placeholder will be replaced by the actual multimedia content to which the `Link` element points. Note that although XHTML was used as an example, the introduced linking mechanism can be used for any XML-based language.

Fig. 3. Linking multimedia content in DIs to presentation languages

5 From DID to XiMPF and back

Since multichannel distribution is getting more and more important for many content providers, the Vlaamse Radio en Televisie (VRT), which is the public Flemish broadcaster, designed a multichannel distribution architecture [7] which is heavily based on the previously discussed architecture. Since they were focusing on their distribution backbones, there were some differences compared to the home media gateway distribution. For example, for storing the multimedia data and the presentation data, they introduced a new storage format called eXtensible Interactive Multimedia Presentation Format (XiMPF). XiMPF is based on MPEG-21 DID, but has proprietary extensions. By applying those extensions to the DID format, it is no longer compliant with MPEG-21 DID.

From an interoperability perspective, this can be considered as a step backwards, since the data stored in XiMPF could only be processed by XiMPF compliant processors. However, the data stored in the XiMPF documents was originally envisaged to only be used in the backbone. Before transmitting the data to the end-user, the XiMPF data was translated into device-specific presentation data, for example, to SMIL. Therefore, the end-user would never notice that the distribution backbone used a proprietary format for storage of its information.

Nevertheless, we are currently living in a world in which multichannel distribution not necessarily happens at the content provider side. For example, in this paper the home media gateway is responsible for realizing the multichannel distribution. Therefore, it is necessary to be able to transport and exchange content which is prepared for multichannel distribution. One way to realize this in an interoperable

way, is to provide the content in a standardized format. Content distributors can then understand the format and more easily adapt the content to their distribution channels. For those reasons, the Multimedia Content Distribution Platform (MCDP) project [8] is currently exploring the conversion of the proprietary extensions in XiMPF into MPEG-21 DID.

6 Conclusions

In this paper, we discussed how multichannel distribution of multimedia presentations can be realized in a home media gateway. This allows the end-user to consume multimedia presentations stored on their home media gateways on a variety of terminals. To realize this, we used the concept of an MPEG-21 DI and demonstrated how DIs can be used to create multimedia presentations which can be consumed on various devices. By extending existing device specific presentation languages with a `Link` element, which points to an MPEG-21 DI, we allowed a DI to become device agnostic. Afterwards, this device agnostic DI was transformed into a device specific DI which makes optimal use of the capabilities of a target class of devices. Finally, we shortly discussed how a Flemish broadcaster used the proposed methodology to realize multichannel distribution in their broadcasting environment. By applying the introduced techniques in a home environment, we moved one step closer to realizing a true UMA experience for home media gateways.

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