

UMA Media base – Metadata Management using Oracle Database System

R.J. Solberg¹, P. Drege¹, A. Perkis², J. Zhang²

¹ Adactus AS, Trondheim Norway

²Centre of Quantifiable Quality of Service in Communication Systems, Norwegian University of Science and Technology, Trondheim, Norway

Abstract

This paper describes the media base in a Universal Multimedia Access (UMA) test bed for handling multimedia presentations in an MPEG-21 environment. The media base introduces an effective way of storing, query organizing, exchanging important metadata and key Digital Items on the server side of a UMA enabled system. The functionality of the media base is demonstrated through an implemented application for streaming of adapted MPEG-4 media resources over the MPEG-21 multimedia framework.

1. Introduction

As the number of different terminals is increasing, the need for content adaptation grows as well. Presenting the media content to the user in an adapted manner becomes crucial, as various terminals have different demands and capabilities. The terminals also access the Internet over a various number of different networks and protocols introducing variations in conditions such as bandwidth, congestion and packet loss. Hence, some form of multimedia adaptation is needed. It is clear that in order to adapt the delivery of the media resources, a negotiation process must take place between the content provider and the receiver. The adaptation itself should be transparent to the user regardless of what type terminal the user disposes. If there is some media resource that the user wants, s/he should have access to it at an ultimate Quality of Experience (QoE). All these issues are concepts of the UMA vision [1]: to create different presentations (to suit different formats, devices, networks and user interests), of the same information, from a single content-base. Users require accessing the Internet and networks from anywhere and at any time regardless of resources, network bandwidth, and client device capabilities. An important tool in achieving media adaptation is the extraction and use of metadata. But what is metadata? Metadata can be defined as data about data, giving information e.g. about a media resource that makes it easier to decide how to process the content. The traditional way of viewing multimedia data as only one entity is fading, and a point of view, where the metadata is separated from the media resource is emerging. In many ways this represents a paradigm shift. The extraction and processing of metadata lifts the decision making level up from the resource- and computational-heavy media resource data, to the low resource demanding and easy accessed metadata level. If metadata such as frame rate,

spatial resolution and bit rate are easily accessible, decisions about what media resources to send can be made fast and computational cheap. Combining metadata extracted from the media resources with metadata from the transmission and usage -environment, makes it possible to adapt the delivery of the media resource. Not only is the storage of media resources demanding due to the size of the data, but there has been no clear defined structure on how to describe the delivery environment, what metadata should be extracted, and how they relate together - until now. The vision of MPEG-21 is to define a multimedia framework, robust enough to cope with this challenge, and also at the same time to flexible to handle the future multimedia challenges of the 21st century.

It seems like two areas that traditionally used to be separated, respectively, the database technology and the multimedia technology, need to be combined in order to achieve the goal of Universal Multimedia Access. This article focuses on how the metadata of media resource can be organized through a collection of different technologies constituting the UMA media base [2].

Figure 1 illustrates the role of a media base in a MPEG-21 environment. The figure shows two Users. One is the content provider, the other the content receiver. They are exchanging information encapsulated in Digital Items, using MPEG-21 Digital Item Adaptation as a means of achieving UMA.

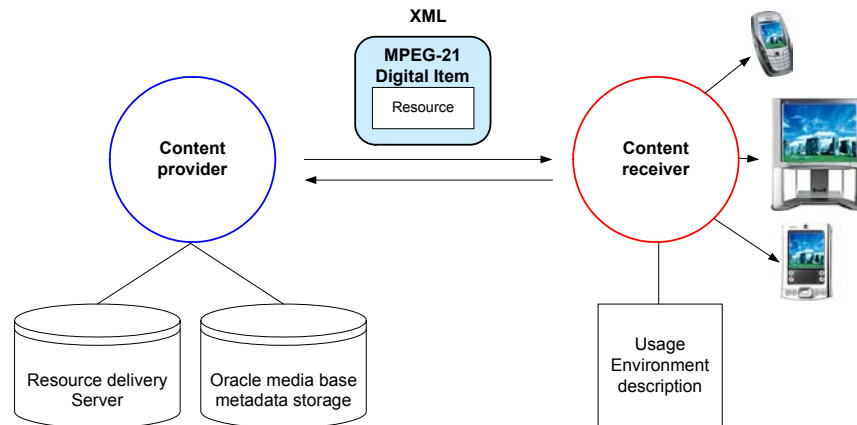


Figure 1: The media base integrated in a MPEG-21 system

2. Media base requirements

A media base can be seen as a controlled collection of media resources, such as text, images, graphical objects, video and audio. A media base can be defined as follows:

“A media base is a set of related components with the ability to create, store, access and query a controlled collection of media resources and their corresponding metadata.”

Hence the media base does not only provide support for different media resource types, but also the ability to create, store, access, query and control them. The demands and functions of a media base are basically the same as a traditional Database Management System (DBMS). The purposes of a media base can be described as [3]:

- *Integration.* Ensures that duplication of data is avoided.
- *Data independency.* The management functions and the media data are kept apart.
- *Concurrency control.* Ensures consistency through rules, which usually impose a form of transaction control.
- *Persistence.* The ability for data objects to survive through different transactions and other program influence.
- *Privacy.* Limiting the access of data to those who are authorized.
- *Integrity control.* Makes sure that the state of the DBMS from one transaction to another fulfils the constraints imposed on transactions.
- *Query support.*
- *Version Control.* Management of different versions of an object could be a requirement of some applications.

The special nature of media resources pushes forward new requirements as well. Apposed to traditional relational data, media resources require huge capacity storage management, combined with media integration. This means that the DBMS should treat the media resources as a native data types.

3. Media base tools and architecture

In order to fulfil this definition, the components constituting the media base must be described. The media base designed in the test bed uses the following tools

- XML
- Oracle9i DBMS
- JDBC
- QuickTime for Java

The key component in the media base is the Oracle9i DBMS, as it creates the relational bonds between the media resource and its corresponding metadata. This paper emphasizes this component, focusing on the functionalities of the DBMS relevant to creating the media base.

The media base stores two main types of data. The first type consists of the MPEG-21 Digital Items which are stored in an Oracle XML table. The second type is the metadata associated with the media resources available for download or streaming. To achieve a structured storage of these data types, the Oracle9i interMedia and Oracle XML are used. These built-in functionalities of the Oracle9i DBMS are described in more detail in the following subsections.

3.1 Oracle interMedia

Oracle interMedia is a build-in standard feature of the Oracle9i DBMS. It enables the platform to handle Internet media content such as, text, documents, images, audio, video together with relational data [4].

Oracle9i is an object relational database. This means that certain types of media objects are defined, with corresponding methods and attributes. The objects are similar to Java or C++ objects, using Binary Large Objects (BLOBS) and File-based Large Objects (BFILE) to form the basis for more complex media objects called ORDAudio, ORDImage and ORDVideo. Oracle interMedia can handle various media resources stored on any HTTP server, accessing the data via the media resource URL address.

3.2 Oracle XML Database

XML is widely used for data exchange between different systems with different properties. The Digital Item is the fundamental unit of transaction within MPEG-21, and is written in XML. This calls for an efficient way of storing, parsing, querying, adaptation and creation of such documents. The Oracle XML Database [5] offers various tools to handle XML such as:

- Parsers written in Java, C, C++ an PL/SQL.
- XML Schema Processor with Java support.
- SQL Utility: A java utility which can generate XML documents and schemas from SQL queries.

These tools are handy when dealing with MPEG-21 Digital Items. Not only when it comes to parsing, but also when there is a strong need for validation, adaptation and query of the XML, which is the case with the Digital Items.

4. Using the media base for streaming media

In order to demonstrate the functionality of the media base, an application has been developed[2]. The application illustrates how the MPEG-21 framework together with a media base can be used to deliver streamed interactive music videos in the Universal Multimedia Access spirit. The capabilities of Oracle interMedia is tested out through automated extraction and storage of media resource metadata. The XML capabilities of the Oracle system have also been tested, not only through Digital Item storage and parsing, but also through schema validation, ensuring that all Digital Items in the system are valid with regards to specified MPEG-21 schemas. The application shows that it is possible to integrate the Oracle9i DBMS into the MPEG-21 testbed, and that the media base is a useful tool for storing and querying both metadata and Digital Items.

Figure 2 illustrates the information flow of the MPEG-21 Digital Items. The outgoing Digital Items from the media base are stored using the Oracle XML Database. Decisions about the media resource to be sent are made based on the stored usage environment and choices made by the user. The flow and their descriptions are given in the Figure.

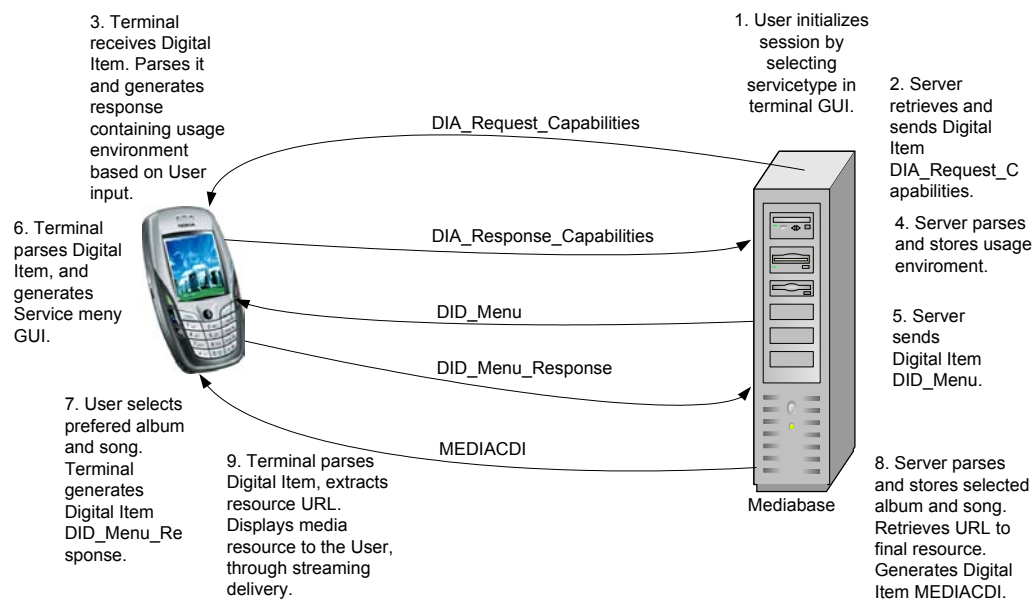


Figure 2: information flow in the application

5. Performance evaluations

This paper documents a functional implementation of a media base for the MPEG-21 UMA Testbed. The Oracle9i

DBMS forms the bases for the media base. The functionality of the media base is demonstrated through an implemented application for streaming delivery of adapted MPEG-4 interactive media resources using the MPEG-21

multimedia framework. The MPEG-21 Digital Items have been confirmed as excellent carriers of MPEG-21 functionality. The application demonstrates the power of JDBC as an interface between the media base and the client, and highlights some of the strengths of the Oracle9i DBMS. The application demonstrates Oracle9i's capabilities to handle media resources and its metadata, and how Oracle9i can store Digital Items through XML storage and retrieval. In this process, Oracle9i interMedia and Oracle9i XML Database has been used. Through Oracle interMedia, media resources and their metadata can be extracted, stored and queried. Through Oracle XML Database, automatic XML Schema validation has been integrated into the testbed. This is a new important feature ensuring MPEG-21 conformance within the testbed.

The media base simplifies decision-making regarding the adaptation process through effective query of metadata. Both Oracle interMedia and Oracle XML Database have proven themselves as powerful tools. Based on years of experience, Oracle continues to dominate the commercial market of data base systems. Oracle has managed to integrate XML and media resources as native data types covering all the requirements described section 2, making it an excellent choice when creating a media base.

6. Conclusions

This paper brings together a range of separate components, making them collaborate in the spirit of Universal Multimedia Access. The application demonstrates a merging of metadata storage, Digital Item storage, and media resource storage, making them work together by using the MPEG-21 framework. As such, the work takes a small step towards the goal of Universal Multimedia Access; a guaranteed multimedia experience, anywhere, any time.

Acknowledgements

At the start of the work with the media base and Oracle, Oracle9i was the current release. During the work, Oracle has introduced a new version of their system called Oracle10g. The interMedia and XML functionalities of the new version are further expanded in the new version, but the principals remain the same.

References

- [1] John R. Smith IBM, *MPEG-21 Digital Item Adaptation: Enabling Universal Multimedia Access*, IEEE Multimedia, January-March 2004
- [2] Runar J. Solberg Master Thesis, *Metadata management for adapted multimedia delivery*, Norwegian University of Science and Technology (NTNU) June 2004
- [3] V.S. Subrahmanian, *Principles of Multimedia Database Systems*, Kaufmann Publishers San Francisco, Inc., 1998
- [4] Oracle OTN, *Oracle interMedia User's Guide and Reference*, Part No. A88786-01Release 9.0.1 June 2001
- [5] Oracle OTN, *Oracle9i XML Database Developer's Guide – Oracle XML DB*, Part No. A96620-02, Release 2 (9.2) October 2002