MPEG-A PART 9 DIGITAL MULTIMEDIA BROADCASTING APPLICATION FORMAT

Muhammad Syah Houari Sabirin[1], Jung Soo Lee[2], Hui Yong Kim[3], Munchurl Kim[1], Yong Han Kim[2]

[1]School of Engineering
Information and Communications University
Daejeon, Korea
E-mail: {houari, mkim}@icu.ac.kr

[2]Dept. of Electrical and Computer Engineering, School of Engineering,
University of Seoul
Seoul, Korea
E-mail: yhkim@uos.ac.kr, jslee2081@lena.uos.ac.kr

[3]Broadcasting & Telecommunications Media Research Division,
Electronic and Telecommunications Research Institute,
Daejeon, Korea
E-mail: hykim5@etri.re.kr

ABSTRACT

Digital Multimedia Broadcasting (DMB) is the mobile TV service based on a digital radio transmission system that provides high quality audio/video and other auxiliary data services. As users want to store the DMB content in their device to be consumed later or to be shared among users, a standardized format needs to be specified to guarantee the interoperability for the DMB contents for various devices. DMB AF (Application Format) specification defines a file format for DMB contents and services. It specifies how to combine the variety of DMB contents with associated information for a presentation in a well-defined format that facilitates storage, interchange, management, editing, and presentation of the DMB contents in protected, governed, and interoperable ways. In this paper we present our implementation of DMB AF as part of the development of DMB AF reference software. Our implementation of DMB AF is developed as the reference software for the standard specification that consists of a three applications: packager, media player, metadata browser and collection of supporting libraries used by the applications.

Keywords: MPEG MAF, DMB, DMB AF

1. INTRODUCTION

Digital Multimedia Broadcasting (DMB) is a multimedia broadcasting service using digital radio transmission system for mobile and handheld devices such as mobile phones. It can operate using satellite (S-DMB) transmission or terrestrial (T-DMB) transmission. The transmission data is packaged in MPEG-2 TS with video encoded with MPEG-4 Part 10 AVC and audio MPEG-4 Part 3 ER-BSAC or HE-AAC v2. It might also contain auxiliary data such as broadcast web site, Java applications, traffic and travel information, MOT slide show and Dynamic Label [1].

Since the storage capabilities of mobile devices getting larger these days, most users want to store their preferred DMB contents for consuming the contents at their preferred time and on their preferred device. Many of them also want to share the contents with other people. Contents providers also want to serve their DMB contents not only through broadcast but also through communication networks. Thus a standardized format needs to be specified to guarantee the interoperability of the DMB contents across various devices from different vendors.

DMB Application Format (DMB AF), ISO/IEC 23000-9, is part 9 of MPEG-A Multimedia Application Format (MAF) standardization development in MPEG that aims to facilitate interchange, management, editing and presentation of multimedia content combined with corresponding metadata [3].

The DMB AF specification is intended to provide the development of DMB applications such as scheduled storage and time-shifted playback of DMB contents, file casting through DMB data channel, DMB content portal over IP, rightful interchange of DMB contents between terminals, user editing or creation from DMB contents and many more.

The structure of this paper is as follows: the multimedia components supported by DMB AF are presented in Section 2 while Section 3 describes how to store those components in an MP4 file format. In section 4, we present our implementation of DMB AF in architectural view as well as the user interfaces. Lastly, Section 5 concludes this paper.

2. DMB AF COMPONENTS

Since the DMB AF specifies the file format for T-DMB and S-DMB contents and services, it should supports components that are used in the DMB specifications from MPEG standard as well non-MPEG standards. The components supported by DMB AF are used with specific limitations and restrictions specified by the DMB specification as described in [1].

Table 1 shows the list of technologies that can be stored as the component of DMB AF. DMB AF supports MPEG-4 Part 10 AVC Baseline profile for video data. For audio data it supports several audio compression specifications: MPEG-1/2 Part 3 Audio layer 2 (MP2), MPEG-2 Part 7 AAC, and MPEG-4 Part 3 Audio. For transport package it supports MPEG-2 Systems TS and MPEG-4 Systems SL. The file format shall be conformance to MPEG-4 Part 12 ISO base file format.

To describe the information about the components, DMB AF can contain metadata specified by MPEG-21 Part 2 DID to describe digital item structure, MPEG-21 Part 4 IPMP Component for protection and governance and MPEG-21 Part 5 REL for rights and license information. A metadata specification from TV-Anytime (TVA) Part 3 is used to describe rich content description and consumption.

The 3GPP TS 26.245 is used to support synchronized text rendering such as movie subtitle or karaoke.

Other auxiliary supported data are JPEG, PNG and MNG for image, HTML, CSS and ECMAscript for hypertext data, Java midlet application and TPEG for traffic information.

Table 1: Components of DMB AF

Category	Standard
Video	MPEG-4 Part 10 AVC
Audio	MPEG-1 Part 3 Audio MPEG-2 Part 3 Audio MPEG-2 Part 7 AAC MPEG-4 Part 3 Audio
System	MPEG-2 Part 1 Systems MPEG-4 Part 1 Systems
File Format	MPEG-4 Part 12 ISO base FF
Metadata	MPEG-21 Part 2 DID MPEG-21 Part 4 IPMP Component MPEG-21 Part 5 REL TV-Anytime Part 3
Timed Text	3GPP TS 26.245
Auxiliary data	JPEG, PNG, MNG HTML, CSS, ECMAscript Java midlet TPEG

3. FILE STRUCTURES

MPEG-4 Part 12 ISO base file format is the basis of file structure for DMB AF. The file format basically comprises of file type identification box (‘ftyp’), movie presentation box (‘moov’), metadata box (‘meta’) and media data box (‘mdat’). A box is a unit of bytes that has its own functionality and can be related to each other as well as inherited to other boxes.

The file type identification box contains information about the type of the file so the player application can appropriately parse the file according to the box structure. The movie presentation box contains information about the contents such as data location, data size, synchronization, etc. and the information on how the contents should be presented. The metadata box contains the metadata used to describe the contents as well as the file format itself. The media data box contains the actual media data such as video bitstreams, image and text data, etc.

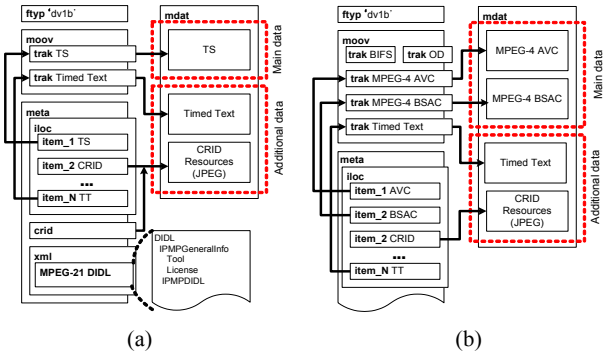

Fig. 1: Example of single type DMB AF file format (a) with MPEG-2 TS package; (b) with ES bitstreams

DMB AF file structure can be composed in two types of file structure: single type or multiple types. Single type means one DMB AF file may contain only one DMB contents (i.e., one main data with additional data such as image, timed text, etc.). As shown in Fig. 1, a single type file structure may contain an MPEG-2 TS package as main data with timed text and image resources as additional data (Fig. 1(a)); or one MPEG-4 AVC video elementary stream (ES) and MPEG-4 BSAC audio ES as main data with timed text and image resources as additional data (Fig. 1(b)). Both file types may contain metadata box in which the metadata such as item location, item information, CRID (content reference identifier, a reference to additional data used by TV-Anytime metadata) information and XML metadata instantiation are stored.

Main data and timed text data are represented in movie presentation box to enable synchronization during the playing. Each data related to a track information box (‘trak’) contains information about the location (offset), size and timestamp of the data. An information location box (‘iloc’) in metadata box contains information about the location of each data, related to the ‘trak’ boxes. An XML instantiation box (‘xml’) contains the textual metadata instantiation of MPEG-21 DIDL encapsulating MPEG-21 IPMP Component, MPEG-21 REL and TV-Anytime metadata.

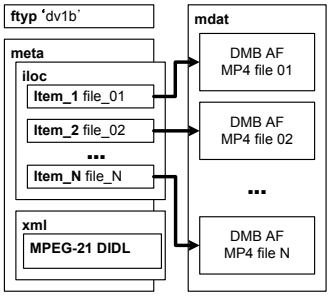

Fig. 2: Example of multiple type DMB AF file format

In multiple type file structure, as shown in Fig. 2, a DMB AF file format may comprises of boxes without movie presentation box. In this file structure, the file format acts as a container of DMB AF “album”. It contains single type DMB AF file as aforementioned while the metadata box contains the information about each DMB AF file’s

location and size, as well as its digital item structure in the MPEG-21 DIDL instantiation in '`xml`' box.

TVA standard uses CRID to uniquely identify content independently of its physical location. DMB AF also adopts the CRID mechanism to author, manage, and provide the content description information independently of the physical location of the associated content. When content resources and the descriptive metadata are stored in the same DMB-AF file, a mechanism to relate the description and the described content inside the file is needed. The CRID may be related to resource like image, text, audio, or any other data. These CRID resources are stored in file format as additional data. As shown in Fig. 1, the CRID resources (in this example is JPEG data) does not represented by movie presentation box, but by CRID box in metadata box while the location is represented in item location box.

If the contents stored in DMB AF are protected, the information regarding the kind of tools and protected data structure are described by MPEG-21 IPMP Components encapsulated in MPEG-21 DID. Content may be represented as Digital Item, in which a Resource element is used to identify a specific content. The information regarding the protection tool and protection scheme is described using MPEG-21 IPMP Component. The IPMP General Information descriptor describes the protection tool used while the IPMP Information descriptor encapsulated in IPMP DIDL descriptor describes the protection information for protected contents.

The information regarding the license granted to the protected content is described using MPEG-21 REL. It is used to define the license that describe what are the conditions given to the principal of the license (the user) on using the DMB AF contents.

4. IMPLEMENTATION RESULTS

As initial implementation of DMB AF, we develop a set of applications as the reference software of the DMB AF standard in forms of three applications and a collection of supporting libraries [2]. This section presents the architectural views of the reference software application as well as the user interface.

4.1 Software Architecture

Our implementation of the packager, as shown in Fig. 3, constitutes of three layers: input layer, processing layer, and packaging layer. The input layer consists of modules that are used to prepare the input files to be packaged into DMB AF file, or provides user with user interface to input any pertaining data such as protection selection or metadata annotations. Some files such as metadata or timed text file need to be verified or pre-processed before the packager can furthermore packaged into DMB AF file.

The processing layer consists of modules that process input data prior to package into ISO base file format. This includes creating track structure, values for all variables of file format's boxes, protecting contents (if any) using external library (a third party library) and creating 3GPP timed text structure.

The packaging layer consists of modules that package the files and pertaining information to the file format. We apply the libisomedia library, a reference software of MPEG-4 ISO base file format, to create basic structure of ISO base file format, and develop a library to define track for TS in ISO base file, add files and metadata defined in processing layer to create final DMB AF file.

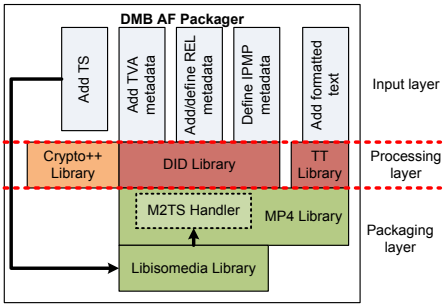

Fig. 3: DMB AF Packager architecture

Fig. 4 shows the architecture of DMB AF media player application. This application reads the DMB AF file and plays the DMB content. The media player constitutes of four layers: input layer, demuxing layer, decoding layer and output layer. The input layer parses DMB AF to acquire TS data stored within the media data box. If the appropriate TS data exists, the second layer called demuxing layer select each data inside the TS input and acquires MPEG-4 OD, MPEG-4 BIFS, Video data and audio data.

The decoding layer consists of modules to parse and decode contents previously demuxed. The contents are separately decoded using appropriate decoder: MPEG-4 BIFS/OD Parser parses BIFS and OD data, Video decoder uses AVC library to decode AVC bitstream, Audio decoder uses BSAC library to decode BSAC bitstream

The output layer consists of modules to render media via user interface. It has a presenter module that renders audio and video using DirectX DirectShow library to play the movie.

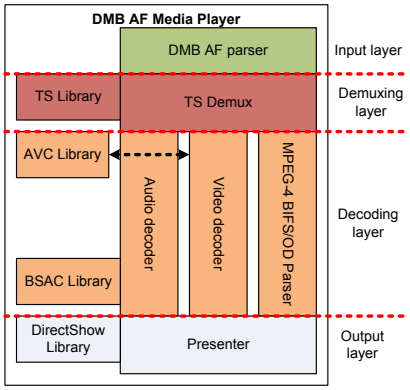

Fig. 4: DMB AF Media Player architecture

The third application is the application that reads the DMB AF file and display the metadata instantiation stored inside the file. The application, the metadata browser, constitutes of three layers: input layer, parsing layer, and output layer.

The input layer parses DMB AF file for MPEG-21 DIDL metadata instantiation and extract the metadata from the

file. Fig. 5 shows the metadata browser architecture.

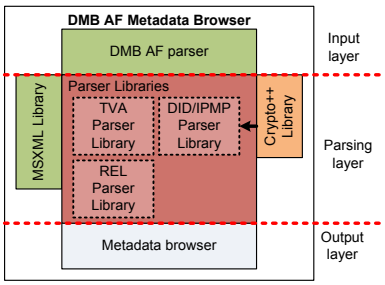

Fig. 5: DMB AF Metadata Browser architecture

The parsing layer consists of module that parses metadata for content description, protection and governance information. It consists of libraries that parse appropriate section of MPEG-21 DIDL instantiation stored inside the DMB AF file. The DID/IPMP parser library parses MPEG-21 DID and its encapsulated IPMP general information as well as IPMP DIDL information (if any). If protected content exist, the library calls protection library to invoke un-protection process. The TVA parser library parses TVA metadata encapsulates in MPEG-21 DID and extract the existing CRID resources stored in the media data box corresponds to the CRID information described by the TVA. The REL parser library parses MPEG-21 REL metadata encapsulated in MPEG-21 DID. All parser libraries use third party library to acquire elements and their values.

Finally the output layer displays parsed information into user interface in form of mini embedded hypertext (HTML) browser.

4.2 System Architecture

This subsection presents the process performed by the applications and the corresponding libraries.

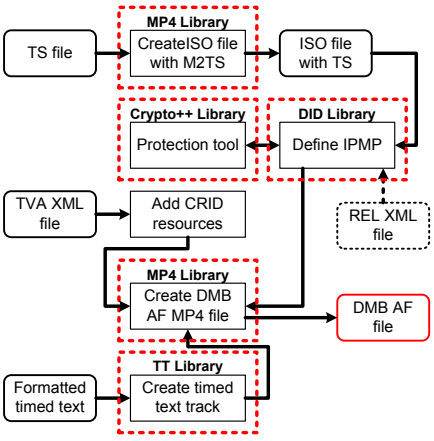

Fig. 6: Creating DMB AF file

In creating DMB AF file, as shown in Fig. 6, the packager application first create ISO base file with M2TS handler from a TS file. This file is the basis of the resulted DMB AF file. Next the IPMP is defined and protection tool is selected. The REL definition can be manually annotated or loaded from an REL XML file. The pre-formatted timed text is loaded and then converted into 3GPP structure. When the input TVA xml file is loaded, the CRID resources are added based on the CRID information described in the metadata. Finally, the MP4 Library restructures the base MP4 file with all of those additional resources and information into a complete DMB AF file.

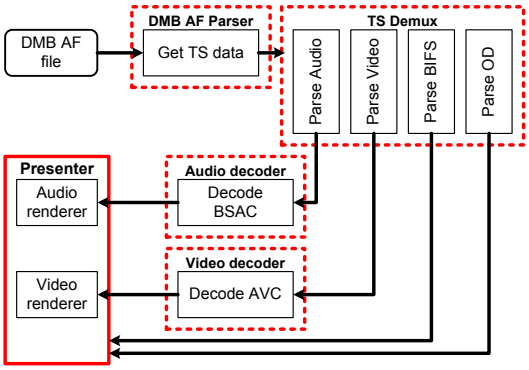

Fig. 7: Playing TS data

In the media player application, as shown in Fig, 7, the process to reads the DMB AF files and plays the TS data relatively simple. Firstly the DMB AF is parsed to extract TS data from media data box then demuxed into audio, video, MPEG-4 BIFS and OD data. Audio data then decoded using BSAC decoder and sent into audio renderer in presenter module. Video data then decoded using AVC decoder and sent into video renderer in presenter module. BIFS and OD data then sent into presented. All information is then used to play movie (video with synchronized audio based on BIFS and OD information).

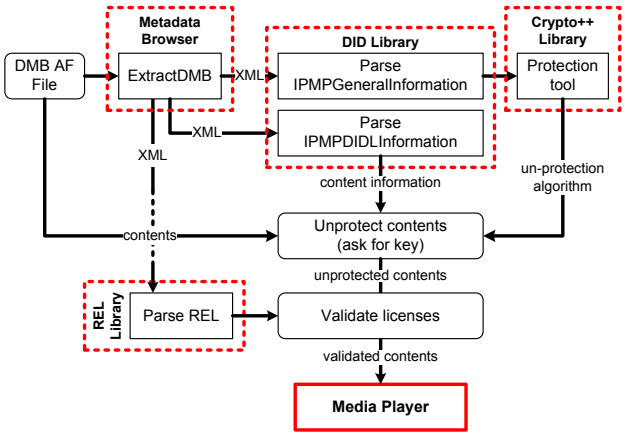

Fig. 8 Un-protecting, validating license and playing protected contents

In case of protected resources are exist within the DMB AF file, the media player shall interact with metadata browser to first parse protection information in the MPEG-21 DID instantiation in meta box, then unprotect the protected content using the protection tool and finally play the contents. In parsing IPMP to un-protect content, first the DMB AF file is parsed to extract the DID instantiation. The DID Library parses `IPMPGeneralInformation` descriptor to get appropriate protection tool information, as well as `IPMPDIDLInformation` descriptor to get content information. Then content are unprotected using

given protection algorithm. Prior the contents are sent to media player to be played, a validator shall validates the license described in the REL. If the license information matches the given conditions, like time information during which the content can be played, then the media player can play the content. Fig. 8 shows the process.

4.3 User Interface

The user interface of the packager is as shown in Fig. 9. It basically represents the modules in packager's input layer and grouped into two parts. The upper part is where the input files are to be added and the bottom part is where the formatted timed text file is synchronized with the audio data.

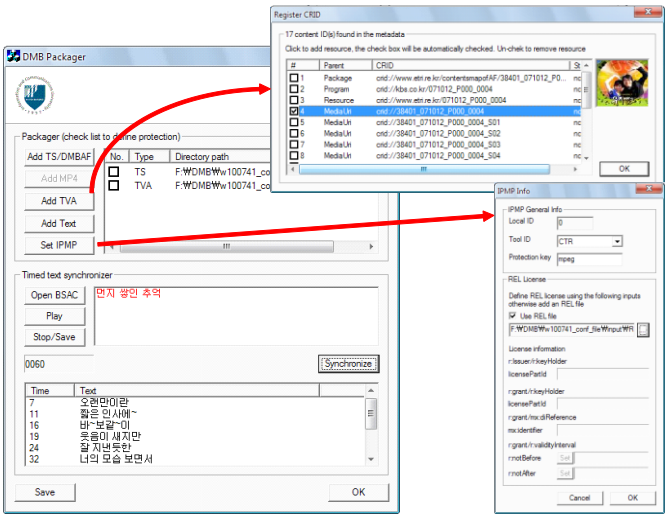

Fig. 9: User interface of the packager

In the upper part, user can add TS file, TVA file, formatted timed text file, and set IPMP descriptions. Adding TVA file will invoke the CRID registration window in which user can define which CRID in the TVA can have CRID resource, and define its protection.

In the IPMP settings, user can select given protection tool and protection key. We utilize AES-128 CTR algorithm for protection for default protection tool because, among other advantages, the encrypted data size is the same as the original data size which simplifies the packing process. In the same window, user can define license description in two ways: manual annotation or load any existing REL metadata file.

The user interface for the DMB AF player, as shown in Fig. 10, is quite simple. It composed of a screen and media controller to play, pause and stop the video.

The metadata browser user interface shown in Fig. 11 consists of four parts to show MPEG-21 IPMP information, TVA content information, TVA segment information and MPEG-21 REL information. By the time the reference software come to finalization step, the metadata browser will be embedded into the media player.

5. CONCLUSIONS

In this paper we presented in briefly the DMB AF specification that facilitates various applications to store, manage, share, and protect DMB contents. By presenting the implementation of DMB AF in packager and player application, we showed how the contents can be managed easily and played appropriately. We also showed how to manage protected contents in file format and how to unprotect the contents.

6. ACKNOWLEDGEMENT

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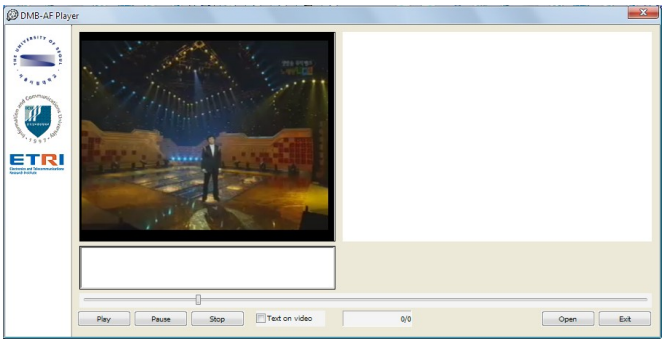

Fig. 10: User interface of the player

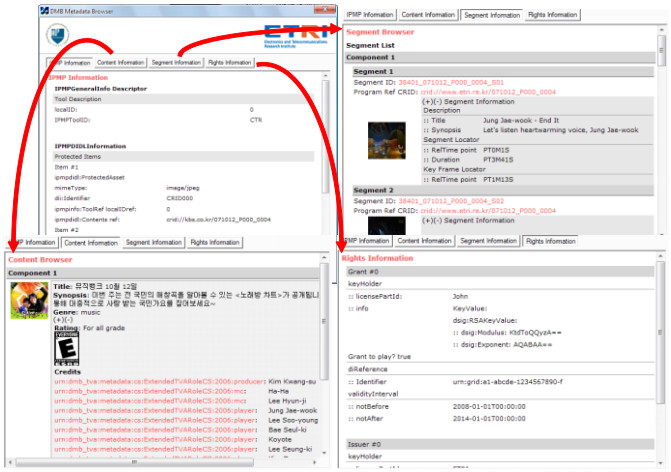

Fig. 11: User interface of the metadata browser

7. REFERENCES

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