Development of a T-DMB Monitoring System

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Abstract: With the start of T-DMB service, diverse multimedia broadcasting services became available in the high-speed mobile environment. In addition to high-quality digital radio (audio) and television (video), diverse data services, such as Dynamic Label Segment (DLS), JPEG Slideshow (SLS), Broadcast Web Site (BWS), Traffic and Travel Information (TTI), interactive service using Binary Format for Scenes (BIFS), and Visual Radio, are being serviced. Currently, there is an increase in demand in the market for T-DMB monitoring system that can support all the data service available. In this paper, we present T-DMB monitoring systems that can simultaneously decode 6 services of different format within the two ensemble, through suitable algorithms and multi-thread techniques.

1. Introduction

In Korea, Terrestrial Digital Multimedia Broadcasting (T-DMB) was commercialized for the first time in the world in December 2005 [1]. T-DMB adopts as its base the European Digital Audio Broadcasting (DAB), also known as Eureka-147 [2]. T-DMB adds to Eureka-147 some digital signal processing, like Reed-Solomon coding and convolutional interleaving, in order to process multimedia contents at an overall bit error rate (BER) of 10^{-8}[3]. With the start of T-DMB service, diverse multimedia broadcasting services became available in the high-speed mobile environment. In addition to high-quality digital radio (audio) and television (video), diverse data services, such as Dynamic Label Segment (DLS), JPEG Slideshow (SLS), Broadcast Web Site (BWS), Traffic and Travel Information (TTI), interactive service using Binary Format for Scenes (BIFS), and Visual Radio, are currently being serviced. Currently, there is an increase in demand in the market for T-DMB monitoring system that can support all the data service available. In this paper, we present T-DMB monitoring systems that can simultaneously decode 6 services of different format within the two ensemble, through suitable algorithms and multi-thread techniques.

2. Data Services and Applications

As mentioned earlier, T-DMB is based on the European Eureka-147. DAB can be divided into audio (programme) and data services. Data services in DAB, such as DLS, MOT Slideshow (SLS), and BWS, are available through Program Associated Data (PAD). Data services which are non-PAD services can be further divided into packet mode and stream mode services. T-DMB uses the stream mode data service in order to carry multimedia data. MPEG4 BIFS is also available for interactive services. Another application of T-DMB is Visual Radio which is a radio service being able to send 2 video frames per second. In case of packet mode data services, BWS, JPEG Slideshow and interactive services using MOT protocol are available, as well as Traffic and Travel information service using TDC (Transparent Data Channel). Fig.1 shows the structure of data services provided by T-DMB.

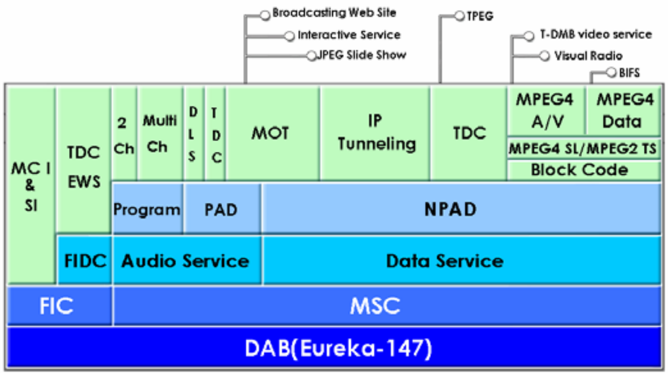

Fig. 1. DAB based T-DMB Application Service

2. 1 MOT Protocol

The Multimedia Object Transfer (MOT) protocol is a transport protocol for the transmission of multimedia content in DAB data channels to various receiver types with multimedia capabilities [4]. MOT is used in order to convey finite objects to a receiver, and these objects are transferred sequentially (using MOT header mode) or from carousel (using MOT directory mode). Objects may be transmitted in PAD or by using packet data services. Several basic end user applications based on the MOT protocol have been defined and standardized. In Korea, two kinds of MOT application are currently available: MOT Slideshow and MOT BWS.

MOT Slideshow: MOT Slideshow consists of a sequence of objects which are presented to the user automatically without interactivity. The MOT Slideshow consists of a sequence of JPEG images. All objects are broadcast in the same sequence order as they should be presented to the user. In case of a news program, images relevant to the news can be sent in the form of slideshow. For a music program, the album jacket or pictures of the singer can be sent. The slideshow service follows the MOT protocol and is available in the PAD of an audio sub-channel or as an independent data sub-channel. The reception time of the objects transmitted, i.e. the slides, may vary depending on the channel environment conditions. Therefore, in order to control the display time of the slides, the objects are transmitted with a trigger time parameter. The receiver terminal displays the slide at the time indicated by its corresponding trigger parameter.

MOT Broadcast Web Site: MOT BWS offers the user an Internet-like HTML data service with local interactivity [5]. Such a service consists of up to several hundred linked objects (HTML pages and image files, e.g. JPEG) which are organized typically in a tree-like structure below a single start page. The objects of such a service are broadcast cyclically in a data carousel [6].

2. 2 Visual Radio

The concept of Visual Radio is very similar to MOT Slideshow. However, the technology behind Visual Radio is totally different. Visual Radio uses MPEG4 BSAC for digital audio broadcasting with a sequence of H.264 images. In essence, it is another variation of DMB. In Visual Radio, an image is sent every 2 seconds. Currently, many different contents are broadcasted through Visual Radio. Images of the radio studio are broadcasted. Image clips from a music video are sent during a radio music show, as well as information relevant to the music being played. Pictures and graphics relevant to the news are broadcasted to aid understanding. Game images are also being broadcasted during a live sports event.

2. 3 TPEG

TPEG stands for Transport Protocol Experts Group and was developed by EBU as an end-user-oriented application for the delivery of road traffic messages. TPEG is organized as a self-contained stream of data which contains all messages as well as provisions for synchronization and error detection. With these characteristics, a TPEG stream should be broadcast over DMB using the Transparent Data Channel (TDC) specification. This results in carrying the TPEG data stream in a completely transparent way over a virtually stream-oriented channel, allowing in-order reception of data bytes; i.e. bytes are received in the order they are transmitted. As an alternative transport mechanism, the transportation of TPEG data within MOT is also possible. In Korea, both mechanisms are used for TPEG applications. Currently, there are 5 different services for Traffic and Travel Information (TTI): CTT (Congestion and Travel Time), CTT-SUM (CTT-SUMmary), SDI (Safety Driving Information), POI (Point of Interest), and RTM (Road Traffic Message). The used bandwidth is 96Kbps, and the transmission interval is 5 minutes or 1 hour, depending on the service, and the data is retransmitted between intervals.

2. 4 BIFS

T-DMB adopted MPEG4 BIFS (Binary Format for Scenes) as an option to enable interactive broadcasting services. MPEG4 BIFS is part of the MPEG4 system used for MPEG4 scene description. In addition, it can overlay 2 dimensional graphics, such as VRML (Virtual Reality Modeling Language), with the video. Interaction among the different graphic objects is also possible. For example, a button can be made to be displayed in the corner of the broadcasted program. If the button is clicked, the object linked to the button can be displayed to the user. A link to a website is also possible. If the return channel is secured, a more sophisticated level of interactive service is possible, such as electronic commerce.

3. System Description

Fig. 2 shows the basic architecture of a T-DMB transmission system. T-DMB system is designed for mobile reception of audio, video, and data services and supports about 2Mbit/s of useful data rate in a 1.536MHz channel. The video and audio used in T-DMB video and Visual Radio are encoded using MPEG4 AVC (ISO/IEC 14496-10)/H.264 and MPEG4 (IOS/IEC 14496-3) BSAC or AAC, respectively. The encoded elementary stream is multiplexed together with the BIFS data (MPEG-4 ISO/IEC 14496-1) Core2D@Level1, used for bidirectional BIFS MPEG4, in the Sync Layer (SL) packetizer and MPEG2 Transport Stream Mux, generating a 188-byte TS stream as outcome [8][9]. The TS stream is inserted into the DAB Mux in data stream mode after going through Reed-Solomon encoding and convolutional interleaving, which is needed to process multimedia contents at an overall bit error rate (BER) of 10-8. The audio PCM stream used for DAB audio service is encoded using the MPEG1, 2 Layer II MUSICAM together with the PAD data, such as DLS or MOT. The encoded stream is then inserted into the DAB Mux in stream audio mode. Data streams such as TPEG and MOT are inserted into the DAB Mux in data packet mode. Each of the streams generated are multiplexed in the Service Mux and Ensemble Mux. This multiplexed signal is then modulated using OFDM and transmitted. The transmitter can use the VHF band III and L-Band as carrier frequency.

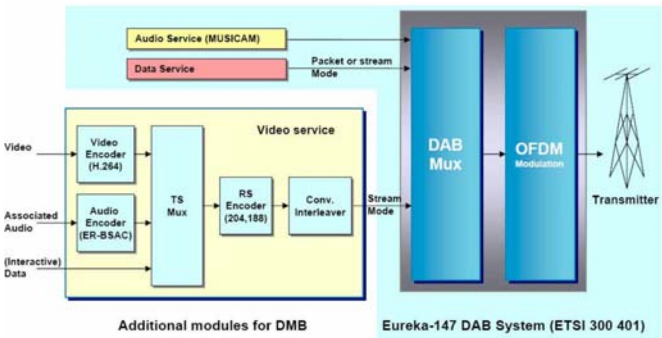

Fig. 2. T-DMB Transmitter Block Diagram

Fig. 3 shows the T-DMB monitoring system block diagram. The antenna receives the DAB signal. The T-DMB receiver consists of a RF Tuner and a baseband decoder. The RF tuner amplifies the reception signal and filters the desired frequency band. The baseband decoder performs OFDM demodulation, channel decoding, MPEG1/2 - Layer II audio decoding, and outer decoding. The T-DMB decoder decodes the audio/video stream and includes MPEG2 TS demultiplexer and MPEG2 SL depacketizer for audio/video transport and synchronization. The DMB decoder also performs TDC (Transport Data Channel) decoding for traffic information services, MOT (Multimedia Object Transfer) decoding for multimedia data transfer, X-PAD (eXtended Program Associated Data) decoding for audio service associated data, and BIFS (BInary Format for Scenes) for interactive services.

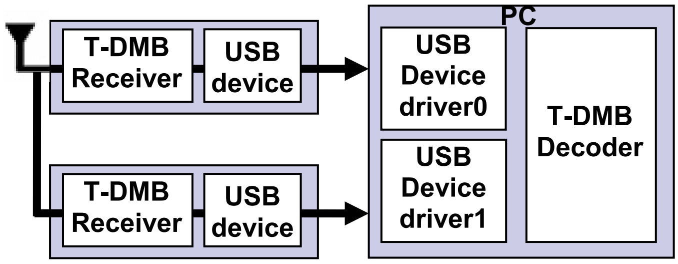

Fig. 3. T-DMB Monitoring System Block Diagram

4. Implementation Results

4. 1 T-DMB Receiver Module

Fig. 4 shows the T-DMB receiver module. The Baseband decoder decodes 3 sub-channel simultaneously, so it can simultaneously decode DMB video, audio, and data service in the same ensemble. In Korea, currently, a maximum of 6 services are serviced within a multiplex. In order to decode 6 services simultaneously, 2 receiver modules are used. Therefore, not only within one multiplex but also within 2 multiplexes 6 services can be decoded with single antenna.

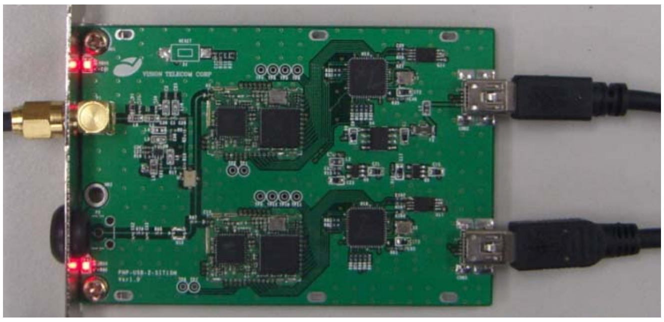

Fig. 4. Implemented T-DMB Receiver module

4. 2 T-DMB Decoder Software

The T-DMB decoder handles MPEG2 TS demultiplexing, MPEG4 SL depacketization, T-DMB video service decoding, data service decoding, and channel decoder LSI control. Depending on the FIC type, the FIC parser decodes MCI (Multiplex Configuration Information), SI (Service Information), and FIDC (Fast Information Data Channel). The services available in the MSC (Main Service Channel) data of the ensemble, as well as the sub-channel organization, can be found. Depending on each service's transport mode, the service type is decided, and the input data is decoded with the corresponding decoder. Two services can be processed simultaneously. Fig. 5 shows the T-DMB decoder functional block diagram.

Fig. 6 shows the software architecture of the T-DMB monitoring system which is implemented on a PC platform. The software consists of 4 basic layers: device driver layer, system program layer, middleware layer, and application layer. In the device driver layer, we implement drivers for USB device 0 and device 1. In the system program layer, we implement MPEG2 TS demultiplexer, MPEG4 SL depacketizer, BSAC/AAC audio decoder, and A/V decode controller on the "Windows XP".

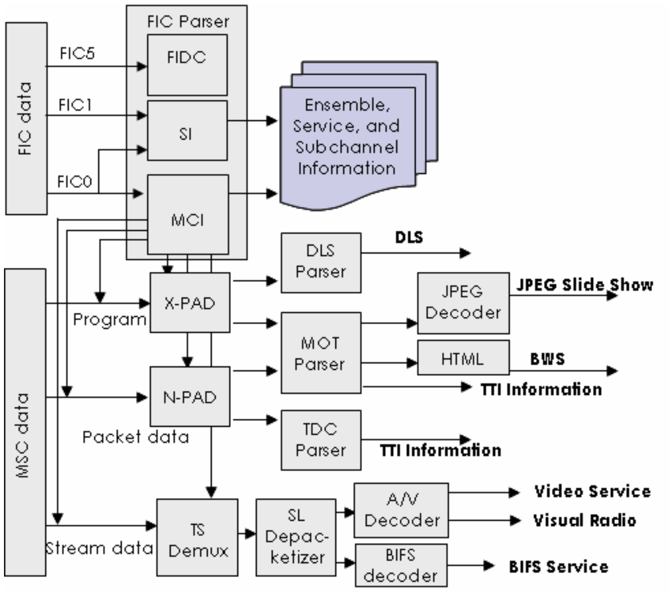

Fig. 5. T-DMB Decoder Functional Block Diagram

The MPEG2 TS demultiplexer block depacketizes TS (Transport Stream), extracts IOD (Initial Object Descriptor), OD (Object Descriptor), BIFS (Binary Format for Scenes), audio SL (Synchronization Layer) data, and video SL data, and stores these data to the appropriate memory space. The MPEG4 SL depacketizer extracts synchronization information and elementary streams for video and audio.

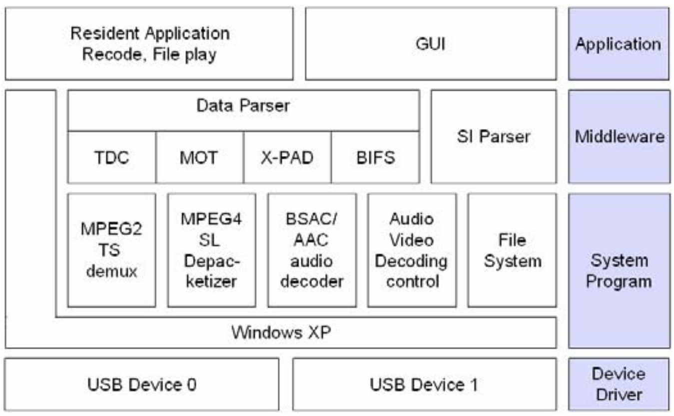

Fig. 6. Software Structure of T-DMB Decoder

The audio decoder can support both MPEG4 ER-BSAC and MPEG4 HE-AAC standards. The A/V decoder controller synchronizes audio and video using the synchronization information extracted from the SL layer. The middleware layer consists of Service Information (SI) parser and data parser. The SI parser analyzes the FIG (Fast Information Group) for data service. The data parser supports TDC decoding for traffic information services, MOT decoding for multimedia data transfer, X-PAD decoding for audio service associated data, and BIFS decoding for interactive services. The application layer consists of a monitoring application and viewer.

5. Conclusion

Employing suitable algorithms and multi-thread techniques, we implemented a T-DMB monitoring system. Fig. 7 shows the still-cut of the developed T-DMB decoder software on PC. The DMB video service, DMB video with interactive data service using MPEG4 BIFS, Traffic and Travel Information (TTI) data service (using MOT Slideshow), audio service with MOT slideshow (SLS) and Dynamic Label Segment (DLS), Broadcast Web Site (BWS), and visual radio are being decoded and displayed simultaneously. Some important information such as service information, Fast Information Channel (FIC) information, and status information including Bit Error Rate (BER), Signal to Nose Ratio (SNR), Received Signal Strength Indication (RSSI), and TTI are monitored and displayed.

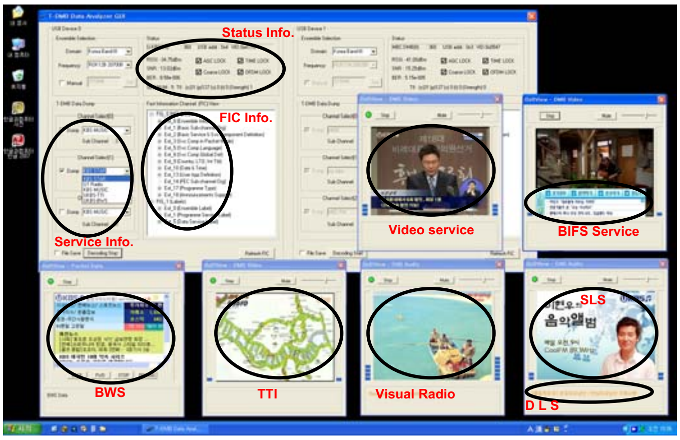

Fig. 7. Implemented T-DMB monitoring Software on PC

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