Development of a Remultiplexer for Digital Multimedia Broadcasting

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Abstract

This paper introduces the development of the remultiplexer which multiplexes MPEG-4 stream into the digital multimedia broadcasting transmission signal. The remultiplexer also has the additional channel coding functions which are essential for mobile reception of moving pictures through the digital multimedia broadcasting signal.

1. Introduction

Since the Eureka-147 DAB(Digital Audio Broadcasting) system[1] was announced in the middle of 1990s, many kinds of applications have been introduced in many countries in the world as well as in Europe. DMB(Digital Multimedia Broadcasting) is one of the applications which have emerged from Eureka-147 DAB system. Especially in Korea, DMB focuses more on the broadcasting of moving pictures and their reception in harsh conditions like in the places surrounded by high buildings and in the highways where vehicles are moving in very high speed.

Although the DMB system is the improved version of DAB system, still the existing devices from DAB system should be used in many part of DMB system.

This paper proposes a multiplexer which multiplexes the existing DAB ETI(Ensemble Transport Interface) signal[2~3] and the MPEG-4 moving picture stream for DMB ETI signal output[4~10]. As the process should be done in the transmission side, it should be done at the ETI level, which is always used in manipulating ensembles for transmission before COFDM(Coded Orthogonal Frequency Division Multiplexing) encoder. And as the multiplexer multiplexes the existing ETI frames with additional MPEG-4 stream, we call it a 'remultiplexer'.

The proposed remultiplexer analyzes the input DAB ETI frames and multiplexes the multimedia data into the ETI frames by changing appropriate information like FIC(Fast Information Channel) and MSC(Main Service Channel) data in the ETI frame. Chapter 2 shows a short introduction of ETI(Ensemble Transport Interface) frame structure and their transmission in DAB system. Chapter 3 shows the roles and functions of the proposed remultiplexer and its position in the DMB transmission system. In chapter 4, we introduced the additional channel coding schemes for mobile reception of the DMB signal. And in chapter 5 we introduced a brief operation of the ensemble remultiplexer. At last we discussed the value of the proposed remultiplexer and their use in the future DMB network and concluded in chapter 6.

2. ETI and DAB transmission

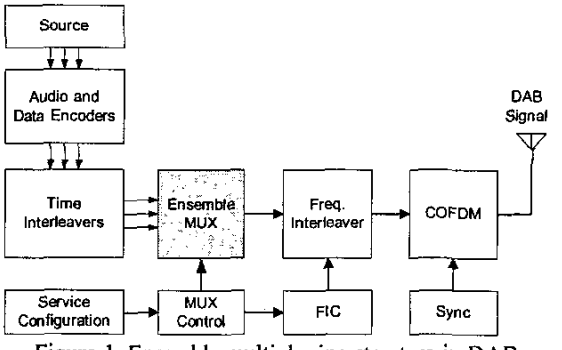

Figure 1. Ensemble multiplexing structure in DAB system

Figure 1 shows the simplified ensemble multiplexing block diagram in DAB transmission system[1~7]. Audio and data services are being encoded with appropriate source coders and they are multiplexed into one ensemble with their service configuration information in the FIC(Fast Information Channel) as well as in the SSTC(Sub-channel Stream Characterization). Table 1 shows the basic parameters for Eureka-147 DAB system [1].

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Table 1. Eureka-147 System Parameters

Parameters	Eureka-147
Modulation	DQPSK
Channel coding	Convolutional : variable rate, constraint length=7
Time interleaving	Depth = 384 ms
Freq. interleaving	Width = 1.536 MHz
Data rate	0.8 - 1.7 Mbps
System Bandwidth	1.536 MHz

An ensemble is the transmitted signal, comprising a set of regularly and closely spaced orthogonal carriers in the OFDM transmission signal. The ensemble is the basic entity, which is received and processed in DAB transmitters and receivers.

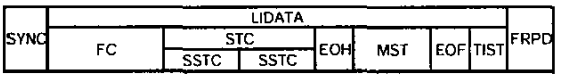


Figure 2. ETI Frame Structure

Figure 2 Shows the ETI(Ensemble Transport Interface) frame structure in the DAB transmission system. These ETI frames are used in relaying the information between DAB service multiplexer and ensemble multiplexers, and sometimes, between source encoders and ensemble multiplexers. All the transmitted data and their configuration information are merged into this frame structure. In general, the LIDATA(Logical Interface Data) part of ETI frame has that kind of information. The configuration of the sub-channels and their addresses are enclosed in the SSTC(Sub-channel Stream Characterization) field in the STC(Stream Characterization) field. MST(Main Stream) field has all the information for the resultant payload data for DAB/DMB signal, that is FIC(Fast Information Channel) and MSC(Main Service Channel). And these ETI frames are directly fed into the COFDM(Coded Orthogonal Frequency Multiplexing) encoder device, in which the resultant DAB/DMB signal is generated.

3. Multiplexing Media data into ETI Frames

Figure 3 shows an example of a multiplexer multiplexing MPEG-4 stream data into incoming ETI frames. Conventional DAB transmission system lets the output ETI signals of the ensemble multiplexer directly fed into the COFDM modulator. But, in here, in order to multiplex MPEG-4 media stream into the existing ETI frame, we let the additional secondary multiplexer(remultiplexer) decode the output of ensemble multiplexer and put the MPEG-4 media stream into the remnant or reserved space for the media stream in the incoming ETI frames.

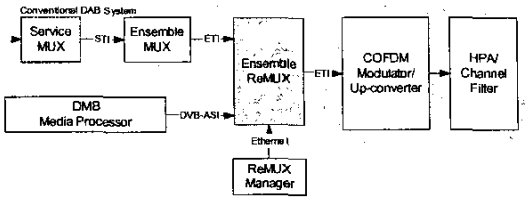


Figure 3. Multiplexing Media data into ETI frame

When inserting the MPEG-4 media stream into the incoming ETI frame, there are several points that have to be considered. One of them is that there should be enough space for inserting media data. This can be done by analyzing incoming ETI frames or by the agreement between ensemble multiplexer and remultiplexer operators before the start of the operation. Secondly, besides the media data, the configuration information should be changed according to the data in the MST(Main Stream Data) fields as well as the SSTC(Sub-channel Stream Characterization) fields. All the other fields such as FC(frame counter) should be maintained accordingly with the incoming ETI frames. In the case that the remultiplexer has some amount of delay in the process of multiplexing, the device should have the ability of changing the TIST(Time Stamp) values for SFN(Single Frequency Network) compatibility.

Figure 4 shows the internal structure of the remultiplexer in the figure 3. The remultiplexer receives the incoming ETI frames that were multiplexed previously and analyzes the frame structure and restructures the ETI frames with incoming MPEG-4 media stream. Then the resultant new ETI frames come out at the output port and goes into the COFDM encoder.

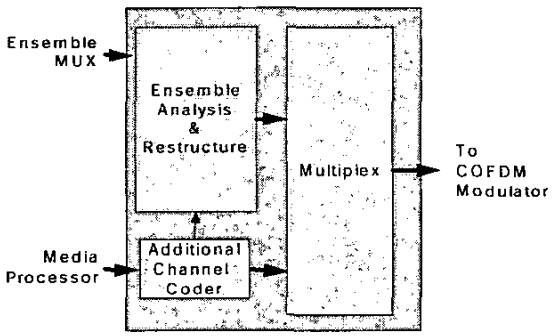


Figure 4. Structure in Remultiplexer

In order to make the transmission data for MPEG-4 media streams, the media processor encodes the moving picture source with MPEG-4 AVC(Advance Video Coding) and MPEG-4 BSAC(Bit Sliced Arithmetic

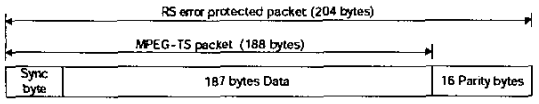
Coding) mechanism. Then this MPEG-4 stream is adapted to MPEG-2 TS stream for the simplicity of handling in the later processing modules like channel coding and multiplexing. Channel coding schemes which are used in the multiplexer are described in the following chapter.

4. Additional Channel Coding Scheme

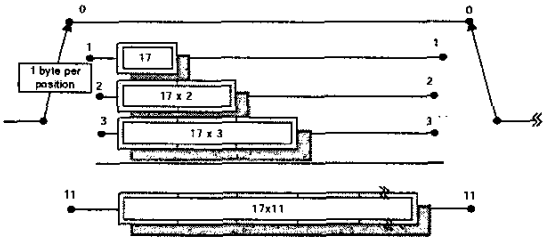
Eureka-147 DAB system was originally designed for CD quality audio stream transmission by targeting the BER(Bit Error Rate) level below 10^{-4}. However, in order for the stable transmission and reception of the moving picture data like MPEG-4 stream, the BER level should go down to 10^{-8}. Thus, the DMB system uses additional channel coding scheme when multiplexing MPEG-4 stream into each of the ETI frames. This channel coding scheme consists of RS(Reed-Solomon) code and convolutional byte interleaving.

Figure 5 (a) shows a brief description of RS coding and convolutional interleaver. The RS code uses the following GF generation polynomial like in Equation (1), and for the 188 TS packets, 16 parity bytes are added to make 204 bytes of protected output packets.

$$p(x) = x^8 + x^4 + x^3 + x^2 + 1 \qquad (1)$$



(a) RS Coding



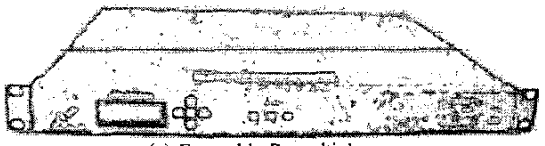
(b) Convolutional Byte Interleaving

Figure 5. Additional Channel Coding Scheme

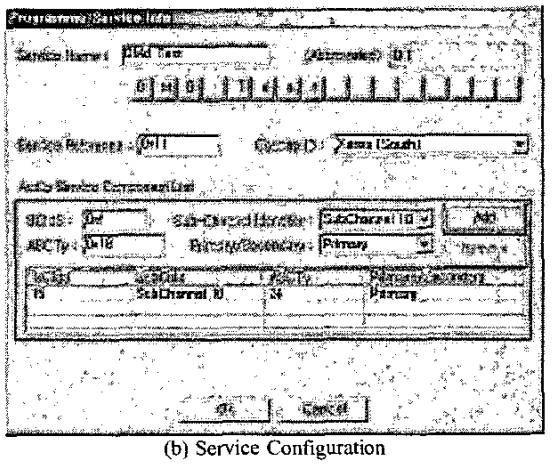
The convolutional byte interleaving scheme follows that of DVB-T standard[4] and it uses 12 branches in the process of convolution as in the figure 5 (b).

5. Ensemble Remultiplexer Operation

Figure 6 shows the implemented ensemble remultiplexer that can be operated with the conventional DAB transmission system in the DAB/DMB transmission system like the structure in the figure 3. The ETI input/output ports and MPEG-4 stream input(DVB-ASI) port are in the backside of the remultiplexer showed in the figure 6 (a).



(a) Ensemble Remultiplexer



(b) Service Configuration

Figure 6. Ensemble Remultiplexer

The figure 6 (b) shows one of the remultiplexer manager software for windows for the specific service parameter settings when MPEG-4 stream is multiplexed in to an incoming ETI frame. The manager software enables the operators to discard one of the existing programs and sub-channels or change the CU(Capacity Unit) addresses of each sub-channels. And also the software has several other functions like analyzing ETI frames and changing the service configurations of the incoming ETI frames.

As described above, one of the important things in the operation of remultiplexer is the management of output ETI frames at the time of rescheduling at the previous ensemble multiplexer. This should be done through the pre-agreement between ensemble multiplexer and remultiplexer operators or by analyzing the incoming ETI frames and do the proper steps in real time. For example, if there is rescheduling signal in the ETI frames of the previous ensemble multiplexer, issuing the rescheduling signal at the remultiplexer by changing the

rescheduling information or discarding rescheduling signal by omitting the related program(sub-channel).

6. Conclusion

We have introduced the development of the remultiplexer which multiplexes MPEG-4 AVC media stream into the digital multimedia broadcasting transmission signal and the additional channel coding functions which are essential for the mobile reception of the digital multimedia broadcasting signal.

As a secondary multiplexer independent of any prior ETI generation system(for example, ensemble multiplexers and service multiplexers), the remultiplexer should know the right time of rescheduling in the incoming ETI frames. These problems will be solved when there is an agreement between ensemble multiplexer and remultiplexer or when the remultiplexer detects the information of the exact time of configuration change in the incoming ETI frames and do the proper process transparently by changing scheduling information or discarding the related sub-channels.

For the SFN(Single Frequency Network) issues, if the TIST(Time Stamp) insertion and rescheduling strategy are well handled in the operation of the DMB network in the remultiplexer, the device will show good performance in the field of DMB network as well as DAB network.

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