Remultiplexing of Ensemble Transport Interface for Terrestrial DMB Service

Joungil Yun, Byungjun Bae, Young Kwon Hahm, and Byung-Ha Ahn

ABSTRACT—In this letter, we present a layered structure of the Korean terrestrial Digital Multimedia Broadcasting (T-DMB) transmission system for multimedia broadcasting service and introduce a device called the Ensemble Remultiplexer which is designed to remultiplex the Ensemble Transport Interface (ETI) for T-DMB service. This letter describes the remultiplexing process of the Ensemble Remultiplexer.

Keywords—Digital Audio Broadcasting, Digital Multimedia Broadcasting, Ensemble Transport Interface (ETI), MPEG-2 TS, remultiplexing.

I. Introduction

Recently, the name terrestrial Digital Multimedia Broadcasting (T-DMB) has been applied to the new terrestrial digital mobile broadcasting service development model encompassing video and data services in Korea. T-DMB is based on Eureka-147 [1] which is a European Digital Audio Broadcasting (DAB) system. It is standardized by adding new functions to Eureka-147 such as a video coding and external protection [2], [3]. For the multimedia services of T-DMB, MPEG-4 advanced video coding (AVC) [4] and MPEG-4 bit sliced arithmetic coding (BSAC) [5] have been selected as the video and audio encoding standards, respectively. T-DMB also supports a data broadcasting that enables interactive dialogue via MPEG-4 binary format for scene (BIFS). For multiplexing and streaming, MPEG-4 synchronization-layer-packetized elementary streams are encapsulated in an MPEG-2 transport stream (TS) after the packetized elementary stream process [6]. Then, Reed-Soloman encoding and convolutional interleaving are used to improve the error protection. Finally, the outer coded MPEG-2 TS is carried in a sub-channel as one of the stream mode service components in the main service channel of the Eureka-147 transmission frame [1].

This letter describes the architecture of the Ensemble Transport Interface (ETI) remultiplexing process to combine a new service component for T-DMB service.

II. ETI Remultiplexing

The normative way to add a new service component in the main service channel is by using the Service Transport Interface (STI) [7] to carry data and control messages in an Ensemble Multiplexer device. In most commercial DAB systems, however, private (not open to the public) transport interfaces are used between the encoder of a service component and the Ensemble Multiplexer. Therefore, in our previous work [8], we proposed the system architecture of a new device named the Ensemble Remultiplexer which is an independent interoperable system for remultiplexing ETI frames. The ETI is an interface signal which allows ensemble information to be routed between the ensemble provider and the transmission network provider, and is defined in a number of layers [9]. Among them, ETI(NI, G.703) is the most commonly used form of ETI which may be used for a direct connection or a connection via a relatively simple network [10]. In this letter, we mainly focus on ETI(NI, G.703). Remultiplexing an ETI between the Ensemble Multiplexer and coded orthogonal frequency division multiplexing (COFDM) modulator to add or remove service components does not require changing the underlying structure of the conventional DAB

Manuscript received Oct. 01, 2004; revised Dec. 14, 2004.

This work was supported in part by the Ministry of Information and Communication of Korea under the title of "the Development of Smar TV Technology."

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transmission system. This means that broadcasting stations or private enterprises already equipped with the conventional DAB transmission system could reduce the cost of equipment for T-DMB service. Moreover, as shown in Fig. 1, an MPEG-2 TS as well as ETIs can be remultiplexed, and it is possible that the local ensemble providers who are provided with an ensemble signal in ETI format from a main ensemble provider through a distribution network could produce a new ensemble signal for their own T-DMB service by using a small-scale remultiplexing system.

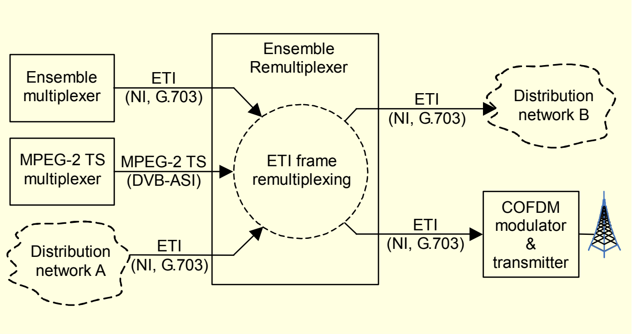

Fig. 1. Remultiplexing ETI using the Ensemble Remultiplexer.

III. The Architecture of ETI Remultiplexing Process

To groom service components selectively for the customized ensemble service, an ETI remultiplexing process must include parsing, synchronized scheduling, service and information editing, and reconstructing. Figure 2 shows the architecture of the ETI remultiplexing process proposed in this letter. The process is implemented in the following four steps.

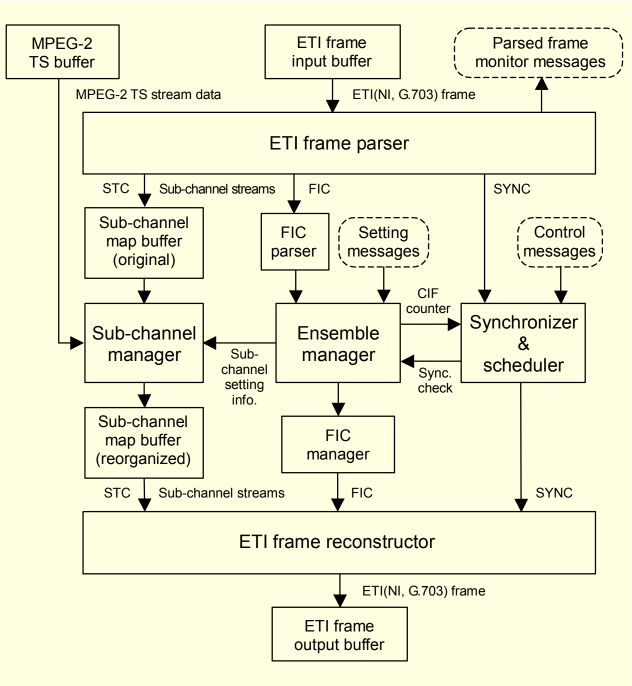

Fig. 2. Architecture of the ETI remultiplexing process.

The first step is getting the input ETI signal and parsing ETI frames every 24 ms. Parsed frame monitor messages are used as both reference values to prepare setting messages and trigger signals to activate the reconfiguration of the remultiplexing process. Figure 3 depicts the structure of the ETI(NI, G.703) frame [9]. As shown in Fig. 3, the ETI(NI, G.703) frame is a uniform stream of 6144 bytes organized every 24 ms. The connection between the related fields shows the parsing procedure. The ETI(NI, G.703) frame can be divided into three parts as follows:

- The synchronization (SYNC) field is for error status indication and frame synchronization. The frame synchronization (FSYNC) field should be one of the two mutually complemented patterns, 0x073AB6 ('0x' indicates a hexadecimal value) and 0xF8C549, and the FSYNC of the successive frames shall be consecutively detected by turn per every 24 ms.
- The ETI logical interface data (LIDATA) field consists of a header part and a payload part. Frame characterization (FC) gives global information of the frame, and sub-channel stream characterization (SSTC) in stream characterization (STC) gives detailed information characterizing the corresponding sub-channel stream data in main stream data (MST). MST also should carry a fast information channel (FIC) which is used for rapid access of information by a receiver while the value of the fast information channel flag (FICF) in FC is 1.
- The frame padding (FRPD) field is the padding information which is inserted at the end of the ETI frame.

The second step is separating the sub-channels by analyzing the relevant SSTC and FIC. Each sub-channel has a corresponding SSTC with the same ordinal number as shown in Fig. 3. Therefore, we used a map data structure to pair each SSTC with a corresponding sub-channel stream. An FIC contains fast information groups (FIGs). Eight types of FIGs are available to provide service information and multiplex configuration information [1]. After parsing the FIGs within an FIC, the FIC parser block hands over information about the ensemble and services to an ensemble manager block.

The third step is reorganizing the sub-channels. In Fig. 2, an error protected MPEG-2 TS is streaming into the sub-channel manager block with a desired constant bit rate, and it is inserted as a stream mode sub-channel which can carry one service component: multimedia service for T-DMB. The sub-channel manager block rebuilds the map data structure of the sub-channel streams with relevant SSTCs according to the sub-channel setting information received from the ensemble manager block.

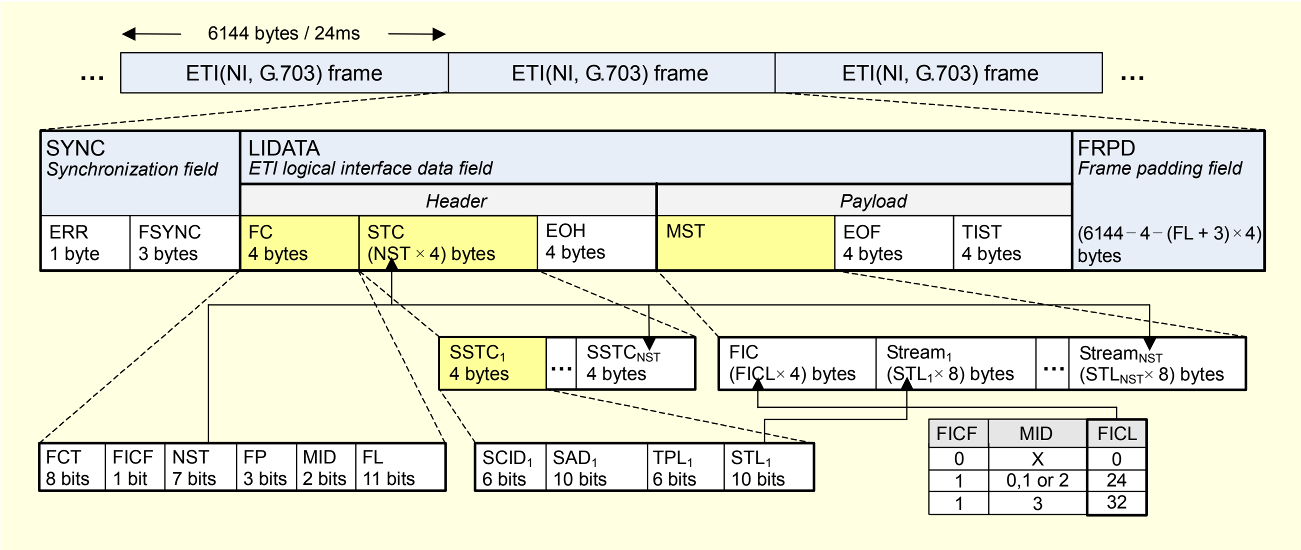

Fig. 3. Structure of the ETI(NI, G.703) frame and the connection between related fields.

Dropping sub-channels within an input ETI is also possible by giving setting messages appropriate for removing them. Setting messages also would include ensemble and service information to reorganize the FIC.

The final step is reconstructing ETI frames. The synchronizer & scheduler block serves the critical tasks of synchronizing and timing, and assures that the whole process for one ETI frame will be finished within 24 ms. Now, the ETI frame reconstructor block derives SSTCs and sub-channel streams from the reorganized map data, the FIC from the FIC manager block, and SYNC from the synchronizer & scheduler block. Here, some sub-fields of FC such as the number of streams (NST) and cyclic redundancy checksum (CRC) values in the end-of-header (EOH) and end-of-frame (EOF) are recalculated. The remultiplexed ETI frame is completely reconstructed by adding padding bytes at the end of it.

IV. Experiment

A field-programmable gate array (FPGA) module and a CPU module of the Ensemble Remultiplexer designed in [8] are used to implement the key function of the ETI remultiplexing. A real-time OS is embedded in the CPU module to realize the process described in section III. Sub-channel editing, configuration setting, scheduling, and controlling are conducted by manager software running on a PC which communicates with the CPU module via a TCP/IP protocol.

A commercial ETI monitor is used to check the input and output ETIs of the Ensemble Remultiplexer. Figure 4 shows the ensemble service information analyzed by the ETI monitor. As shown in Fig. 4(a), an input ETI has two audio services. By editing and setting the Ensemble Remultiplexer, we removed an audio service labeled 'Audio Service 2' and inserted a new multimedia service labeled 'DMB Service'. Figure 4(b) shows the ensemble information of an output ETI. The label of the ensemble is also changed to demonstrate the FIC reconfiguration function. Finally, the synchronization of the ETI is verified by checking the zero frame continuity error report of the ETI monitor.

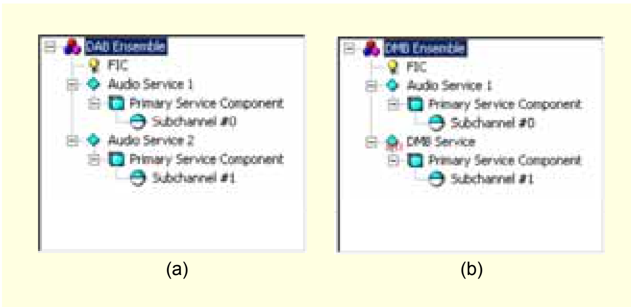

Fig. 4. Ensemble service information analyzed by a commercial ETI monitor: (a) original ETI from an Ensemble Multiplexer (input ETI of our Ensemble Remultiplexer), (b) reconstructed ETI from the Ensemble Remultiplexer.

V. Conclusion

We raised the need of ETI remultiplexing and described the necessary processes to remultiplex ETI frames. The most important issue is how to preserve the consecutive synchronization of the input and output ETI frame accurately. Therefore, a four step process is designed and implemented effectively as a real-time embedded software running on the CPU module of the Ensemble Remultiplexer to remultiplex every ETI frame within 24 ms. The experimental result verifies the proposed method.

T-DMB service will be initiated in the near future, and various commercial products including our Ensemble Remultiplexer, multimedia contents, and other related services relevant to it will come onto the market.

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