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Development of a DVB-x2 Broadcast Gateway with Common Modulator Interface

Yongje Woo[1], Mingoo Kang[1], and Jeongwook Seo[2]

[1]Devision of Information & Telecommunications, Hanshin University
e-mail: cosch0610@gmail.com, kangmg@hs.ac.kr
[2]Department of Information & Communication Eng., Namseoul University
e-mail: jwseo@nsu.ac.kr (Corresponding Author)

Abstract

In this paper, a Digital Video Broadcasting-2nd Generation (DVB-x2) broadcast gateway with Common Modulator Interface (CMI) is presented for all the DVB-x2 services such as DVB-T2 for terrestrial, DVB-C2 for cable, and DVB-S2 for satellite. As a single platform, it is designed and implemented to support any remotely distributed DVB-x2 modulators by the CMI based on the T2-MI protocol for DVB-T2. In addition, it consists of a broad gateway control, an input pre-processor, a common mode adaptation, a common stream adaptation, a common layer generator, and a CMI packet generator. The experimental results shows that it can improve the buffer usage by about 24% at the cost of only about 3% overhead increase, compared to the use of separate DVB-T2/C2/S2 buffers.

Keywords: *Broadcasting, DVB-x2, Modulator Interface, Gateway.*

1 Introduction

A lot of digital broadcasting standards have been developed by Digital Video Broadcasting (DVB) project [1,2]. The 1st generation family of DVB standards denotes DVB-T for terrestrial, DVB-C for cable, and DVB-S for satellite. Recently, the 2nd generation family of DVB standards (e.g. DVB-T2/C2/S2) has been widely deployed to offer higher spectral efficiency, robustness, and flexibility than the first generation family [3–8]. DVB-T2/C2/S2 (called DVB-x2 in this paper) systems use a compatible BaseBand (BB) frame for data packaging. Also, a DVB-T2 gateway can accept one or more transport streams (TSs)

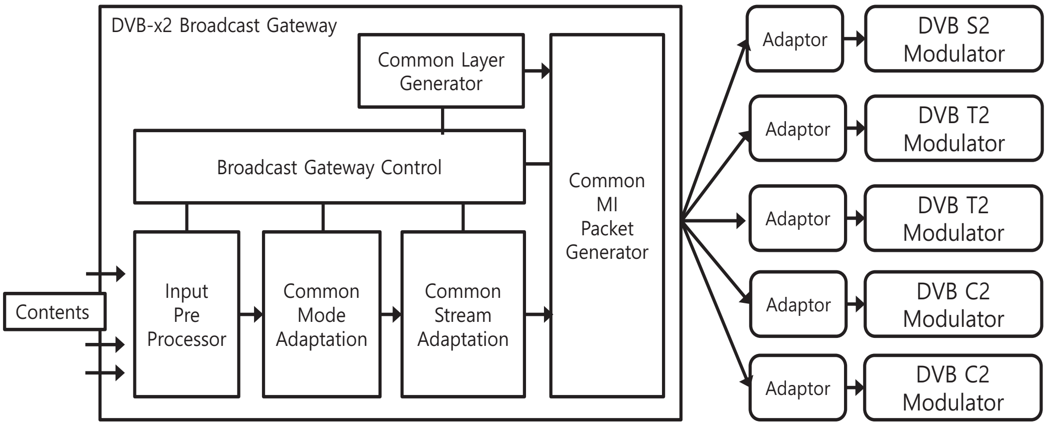

Figure 1: Block diagram of the proposed DVB-x2 broadcast gateway.

and/or GSE streams at the input and generates, based on the input streams, a sequence of T2-MI packets at the output [9], where T2-MI packets stream must be encapsulated into appropriate lower protocols for reliable distribution of T2-MI packets to DVB-T2 transmitters. Though many broadcasting companies want to provide multi-broadcasting services through the 1st and the 2nd DVB standards, it may cause the CAPEX/OPEX cost problems due to required broadcast facilities and equipment.

In order to solve the problems, therefore, this paper designs and implements a novel DVB-x2 Broadcast Gateway (BG) supporting all-in-one broadcasting services by exploiting the common modulator interface (CMI) based on T2-MI. It will consist of broad gateway control block, input pre-processor block, common mode adaptation block, common stream adaptation block, common layer generator block, and CMI packet generator block. The remaining of this paper is organized as follows. In Section 2, the design and implementation of the proposed DVB-x2 broadcast gateway is detailed. Section 3 shows Some experimental results to evaluate the proposed DVB-x2 broadcast gateway. Concluding remarks are mentioned in Section 4.

2 Proposed DVB-x2 Broadcast Gateway

The general concept of the gateway plays a role that changes data formats suitable to the network standards. The proposed DVB-x2 BG as a single platform, which uses only one data format, is able to support all of DVB-T2/C2/S2 standards. As shown in Fig. 1, it is designed by using the T2-MI concept in the DVB-T2. It consists of six components such as Broad Gateway Control, Input Pre-processor, Common Mode Adaptation, Common Stream Adaptation, Common Layer Generator, and CMI Packet Generator. Thus, it can process

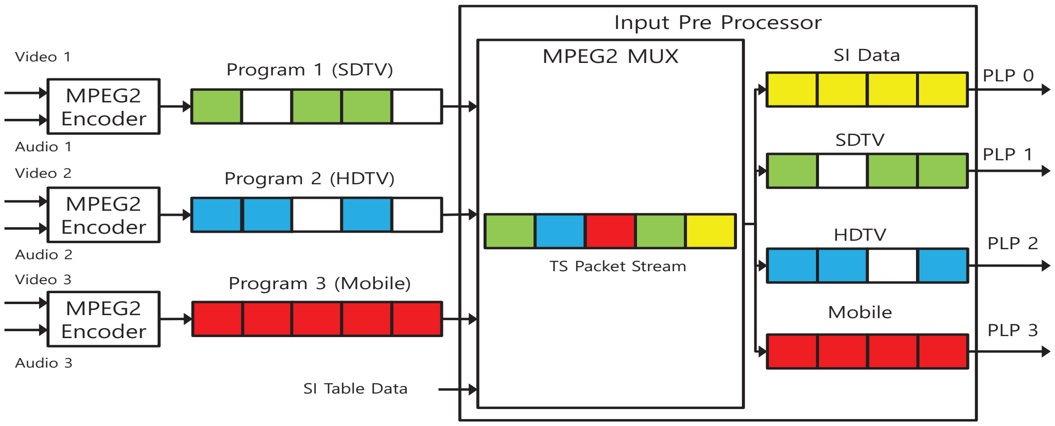

Figure 2: Input pre-processor for TS input streams.

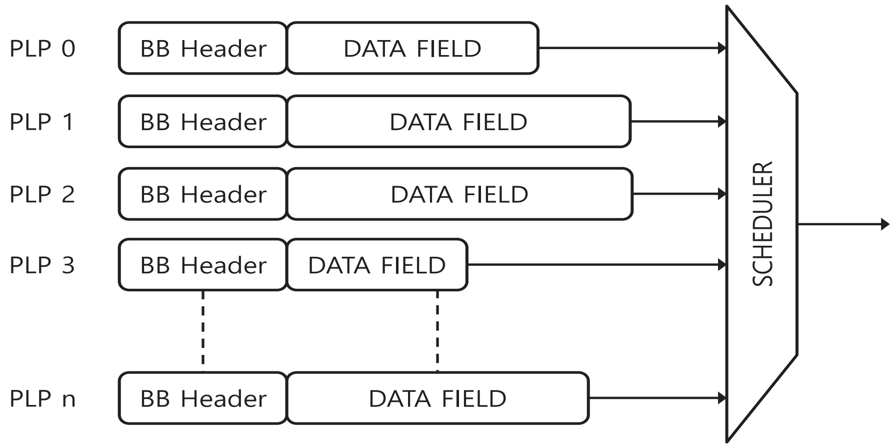

Figure 3: Common streams scheduler.

all the contents such as audio, video and data by the input pre-processer and common mode/stream adaptation included in all DVB-x2 systems. To reduce the investment cost incurred by the proposed DVB-x2 BG deployment, only the Adaptor is attached to the existing DVB-x2 modulators. The Adaptor analyzes the Common MI Packets and transfers the BaseBand frames and additional information for the corresponding DVB-x2 modulators by its software upgrades or USB-type devices. There are four types of input streams such as MPEG-2 Transport Stream (TS), Generic Stream Encapsulation (GSE), Generic Fixed Packetized Stream (GFPS), and Generic Continuous Stream (GCS) for DVB-x2 systems [10]. The input streams for the proposed DVB-x2 BG are the same as TS, GSE, GFPS, and GCS which are processed by the Input Pre-Processor shown in Fig. 2. The Input Pre-Processor selects the input streams to be processed and parses their packet header or executes TS demul-

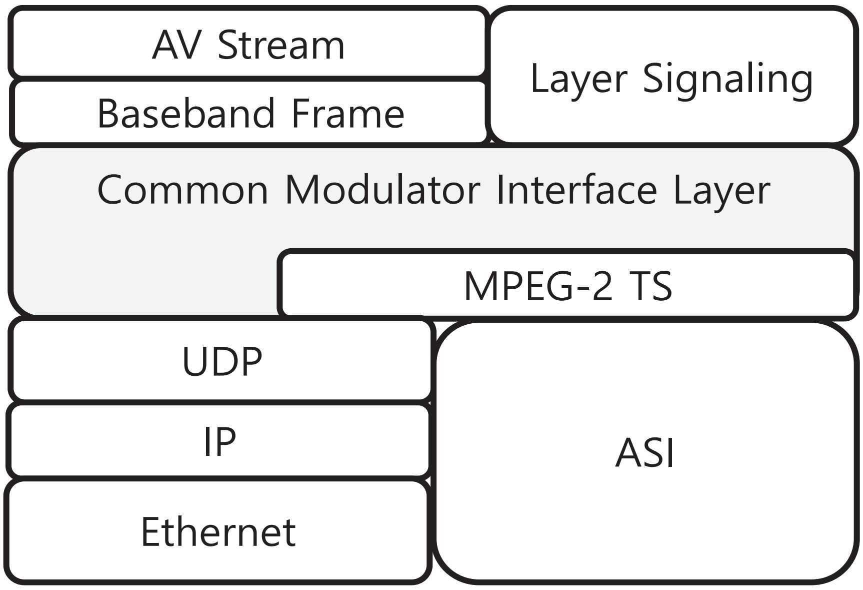

Figure 4: Protocol stack for the proposed DVB-x2 broadcast gateway.

tiplexing, etc. In other words, we can grasp the type of input streams and the number of input streams (single or multiple) by the Input Pre-Processor. The Common Mode Adaptation executes input interface, Cyclic Redundancy Check (CRC)-8, and BaseBand header signaling functions. Also, it supports the slicing of DVB-S2 and the input synchronization of DVB-T2/C2 and executes a mapping from input streams to the BaseBand frames. The Common Stream Adaptation distinguishes between single and multiple input processing. In case of the single input processing, it adds the BaseBand header information according to the service configuration. After that, it executes the BaseBand scrambling. In case of the multiple input processing, it has to execute the scheduling based on the HFIFO method which dynamically changes the priority of traffic processing in order to adjust transmission load imbalance as shown in Fig. 3. Finally, the CMI packets are generated and transmitted to the adaptors of the corresponding DVB-x2 modulators. The basic information in the CMI packets consists of the Baseband frames and their configuration, the signaling information of the transmission system, etc.

In order to transmit the CMI packets, Asynchronous Serial Interface (ASI) and Ethernet for the short-distance and the long-distance are used, respectively. In Fig. 4, the CMI protocol stack is illustrated. The CMI packet structure is shown in Fig. 5 where there are Common MI header, Payload, Padding, and CRC-32. Especially, the Common MI header has packet configuration information. The packet type field denotes the the transmitted packet type. The packet count filed is used to know the packet order for packet reassembly.

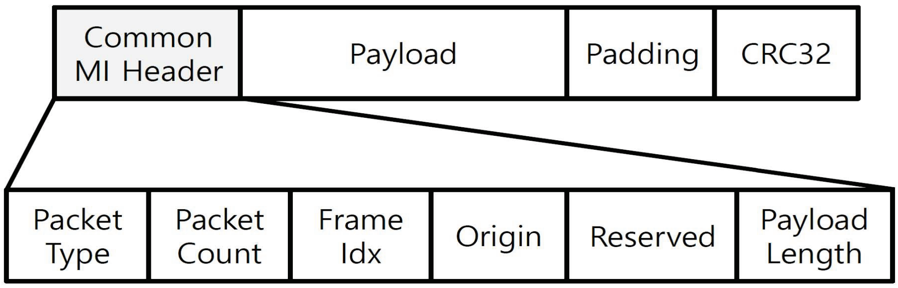

Figure 5: Packet structure of the CMI layer.

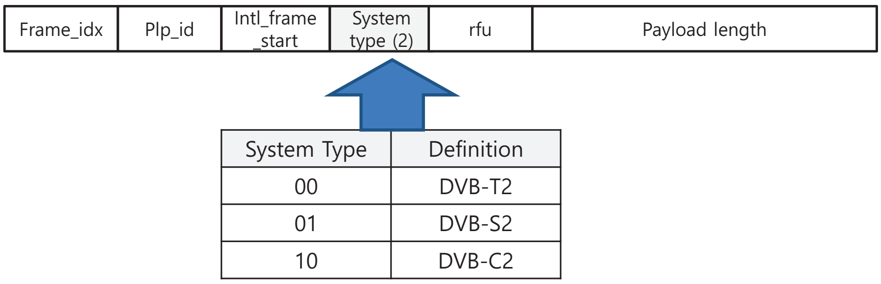

Figure 6: Payload structure of Baseband Frame in the CMI layer packet.

The frame index field is used to distinguish the frame types of the DVB-x2 systems. The origin filed has the information of the DVB-x2 systems where 00 bits denotes the DVB-T2 system, 01 bits denotes the DVB-S2 system, and 10 bits denotes the DVB-C2 system. The payload length is the length of the transmitted payload.

The Baseband frame transmitted by the CMI Layer Pakcet is represented in Fig. 6, and the Layer Information transmitted by the CMI Layer Packet is represented in Fig. 7. According to the Layer Information, the configuration of CMI Layer Packets will be changed. The Layer Information field has three bits: 000 (DVB-T2), 001 (DVB-S2), 100 (DVB-T2 & DVB-C2), 110 (DVB-T2 & DVB-S2 & DVB-C2), etc. Fig. 8 illustrates the flowchart of the CMI layer packet generation to support the multiple transmission to different DVB-x2 modulators. For DVB-T2, the Layer Signaling will generate L1 pre-signal, L1 post-configuration signal, and L1 post-dynamic signal. In addition, it will generate L1 signal and L1 part2 signal for DVB-C2 and Start of Frame (SOF) information and Physical Layer Signaling (PLS) information for DVB-S2. In the final step, it will generate the CMI Layer Packet which may slightly increases the packet overhead due to the additional information when compared with the single transmission. In Fig. 9, the implementation result of the proposed DVB-x2 BG is illustrated. Basically, it has four componets:

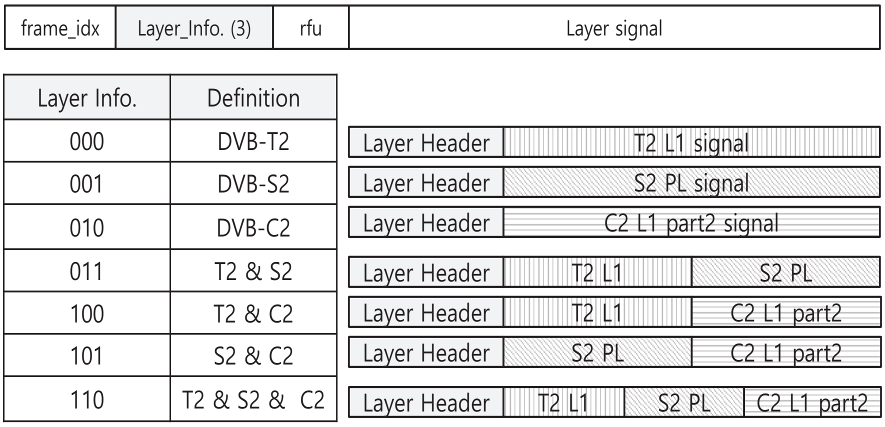

Figure 7: Payload structure of Layer Signaling in the CMI layer packet.

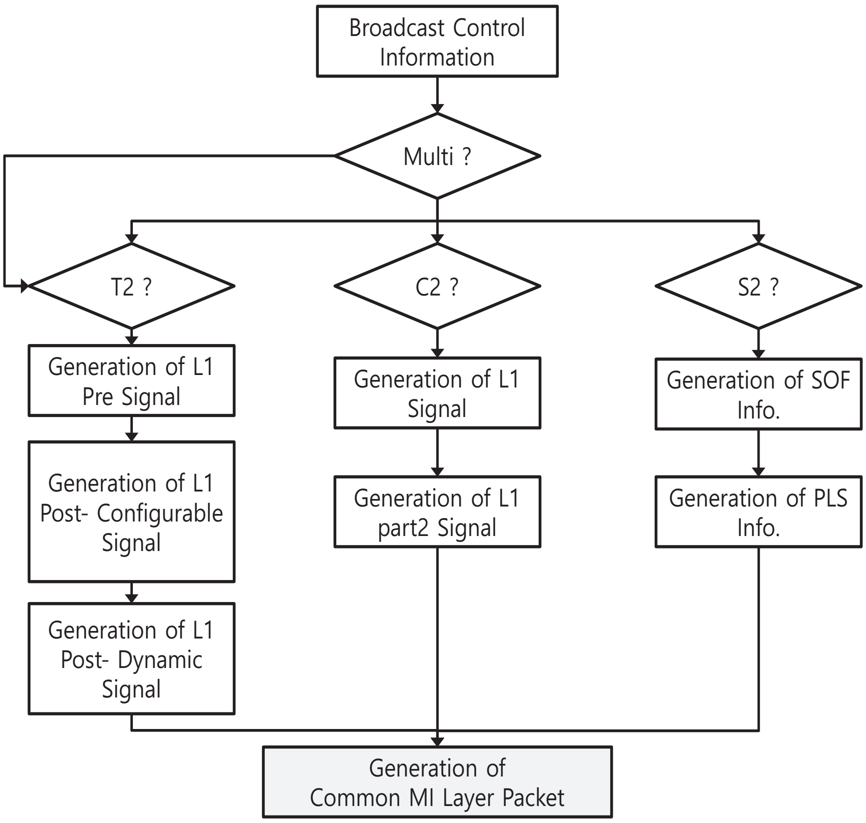

Figure 8: Flowchart of the CMI layer packet generation.

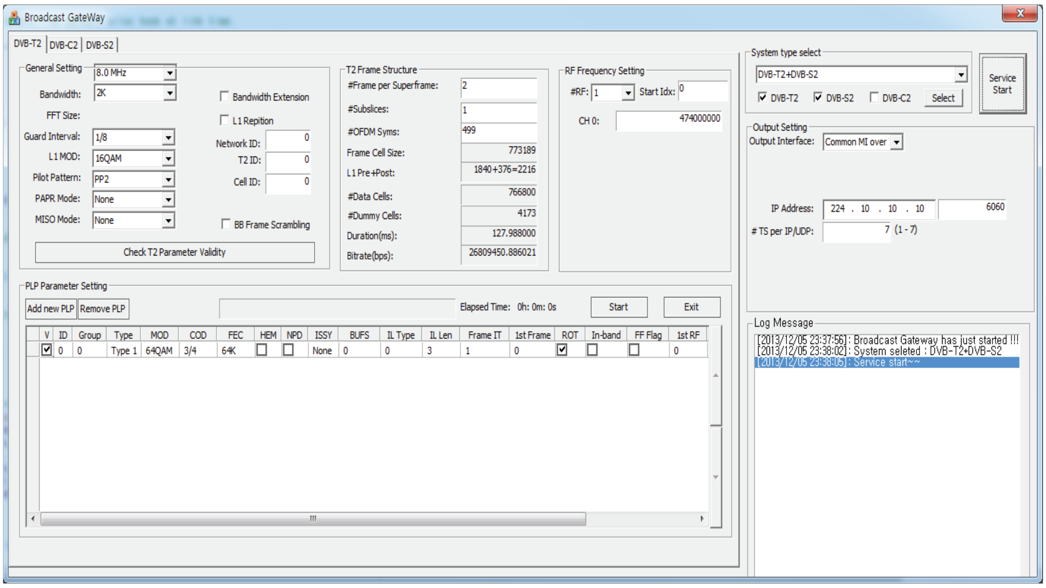

Figure 9: Implementation of the proposed DVB-x2 broadcast gateway.

1) System Type Selection (e.g. DVB-T2, DVB-S2, DVB-T2 & DVB-C2), 2) System Configuration (e.g. General Setting, Frame Structure, RF Frequency Setting, Physical Layer Pipe (PLP) Parameter Setting), 3) BG Ouput Setting (e.g. CMI Layer Packet, IP Address, Number of TS per IP/UDP, etc.), 4) Log Message.

3 Experimental Results

To test and verify the proposed DVB-x2 BG performance, the DVB-x2 system and simulation parameters are described as follows. First, the DVB-T2 system consists of 8MHz bandwidth, 2K FFT, 1/128 guard interval, PP7 pilot pattern, 64QAM modulation, and 2/3 code rate. Second, the DVB-C2 system consists of 8MHz bandwidth, 4K FFT, and 1/64 guard internal. Third, the DVB-S2 system consists of QPSK modulation and 3/5 code rate. The PLP consists of Type1, 64QAM modulation, 3/4 code rate, 64K Baseband frame size, and Normal Mode. The bitrate (TS rate) is 10,4Mbps, and the duration is 180 seconds. Also, the Buffer Usage is considered as a performance metric. As mentioned before, the proposed DVB-x2 BG can support the multiple DVB-x2 services by the CMI Layer Packets, whereas it may increase the packet overheader of about 3% when compared to each DVB-T2/C2/S2 service.

From Fig. 10 to Fig. 12, the buffer usages of the proposed DVB-x2 BG are compared to that of each DVB-T2/C2/S2 gateway. First, when compared to the DVB-T2 gateway with average buffer usage of about 10,307.46 Kbps, the

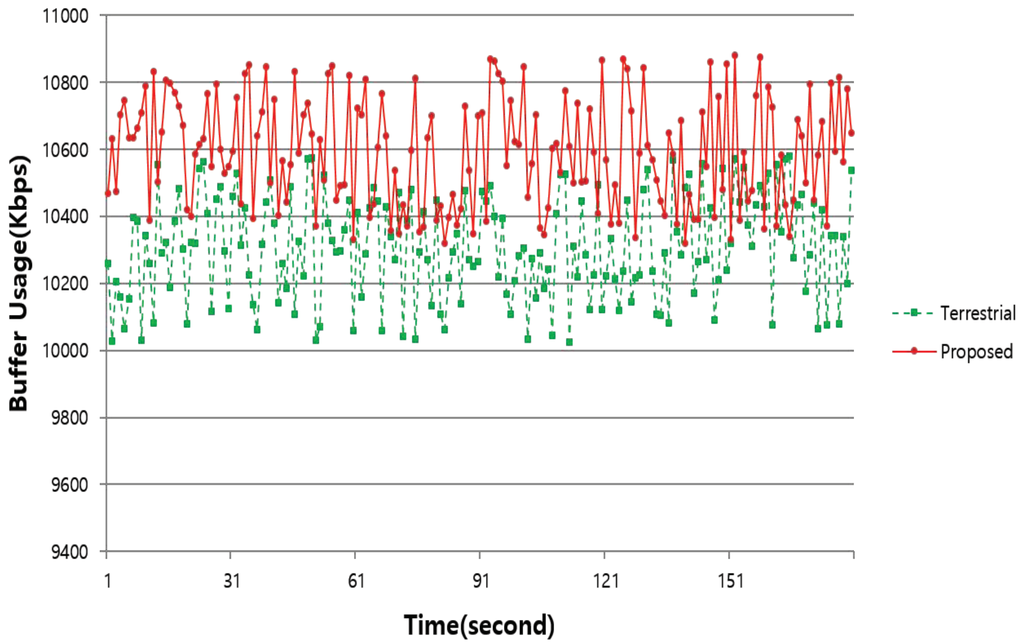

Figure 10: Comparison of buffer usage between a DVB-T2 gateway and the proposed DVB-x2 broadcast gateway.

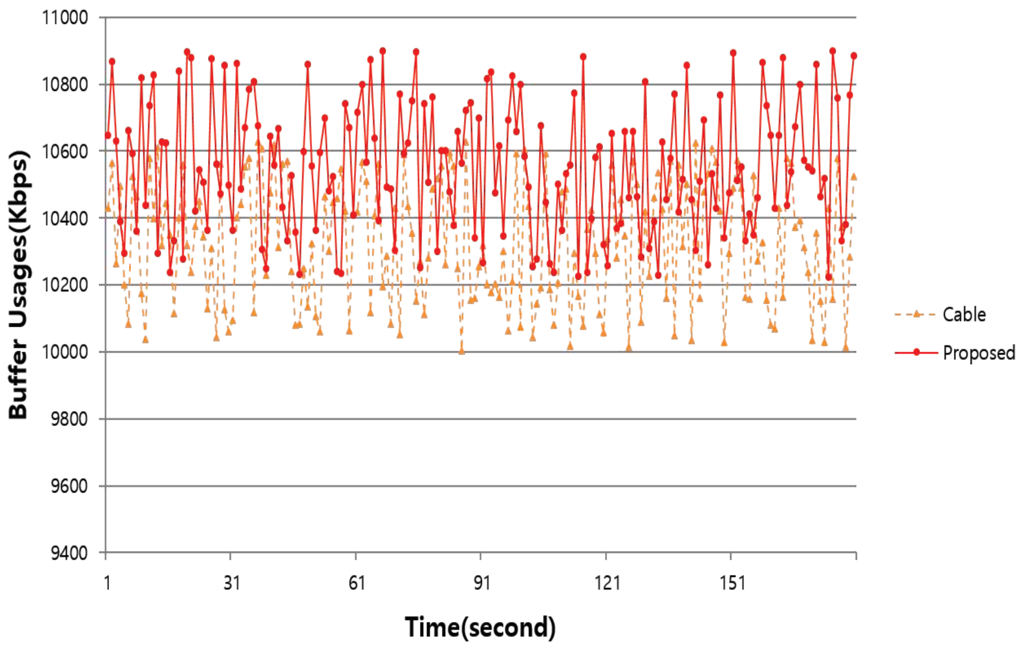

Figure 11: Comparison of buffer usage between a DVB-C2 gateway and the proposed DVB-x2 broadcast gateway.

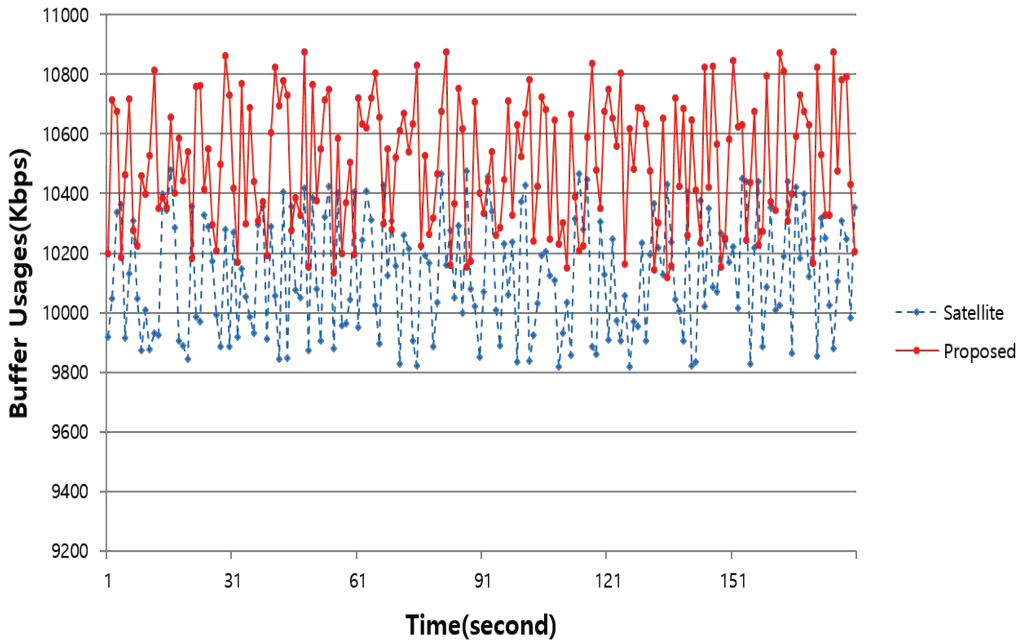

Figure 12: Comparison of buffer usage between a DVB-S2 gateway and the proposed DVB-x2 broadcast gateway.

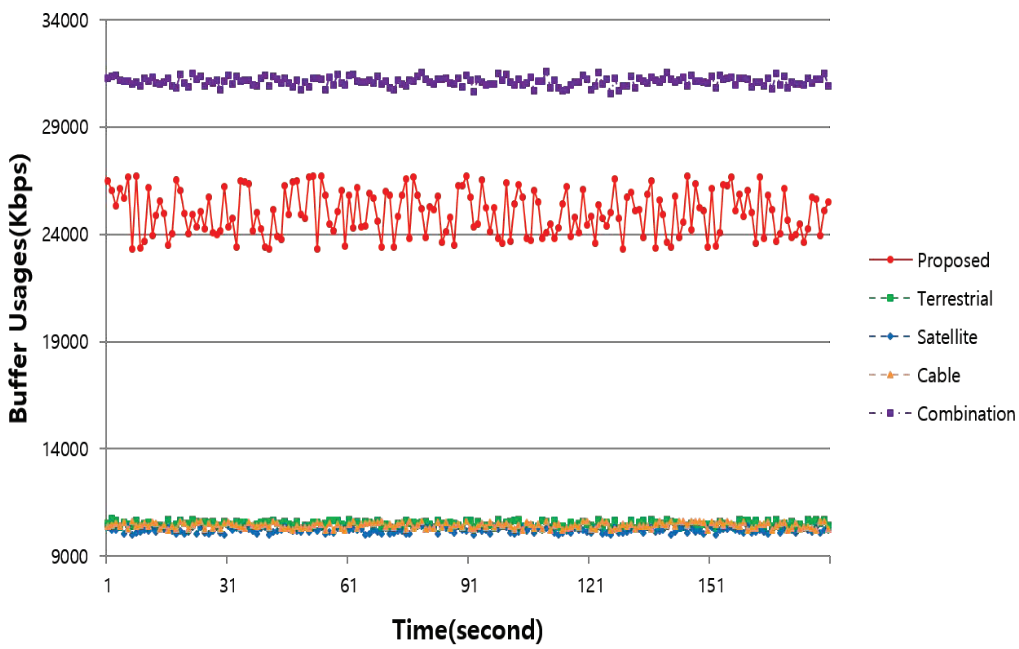

Figure 13: Comparison of buffer usage between the combination of the DVB-T2/C2/S2 gateways and the proposed DVB-x2 broadcast gateway.

proposed DVB-x2 BG has the average buffer usage of about 10,593.17 Kbps. Next, when compared to the DVB-C2 gateway with average buffer usage of about 10,325.96 Kbps, the proposed DVB-x2 BG has the average buffer usage of about 10,554.32 Kbps. Finally, when compared to the DVB-S2 gateway with average buffer usage of about 10,127.07 Kbps, the proposed DVB-x2 BG has the average buffer usage of about 10,499.7 Kbps. Thus, the buffer usage performance of each DVB-T2/C2/S2 gateway (namely, in case of single transmission) slightly outperforms that of the proposed DVB-x2 BG. However, in case of multiple transmission, the proposed DVB-x2 BG outperforms the combination of the DVB-T2/C2/S2 gateways as shown in Fig. 13. It can provide about 24% gain of average buffer usage since the proposed DVB-x2 BG has the average buffer usage of about 24,989.44 Kbps, and the combination of the DVB-T2/C2/S2 gateways has that of about 31,133.19 Kbps.

4 Conclusion

In this paper, the useful DVB-x2 BG was designed and implemented to support multiple transmission for all-in-one broadcasting Services. At the cost of only 2-3% overhead increase, it can transmit all the streams such as TS, GSE, GFPS, and GCS to any combinations of remotely distributed DVB-T2/C2S2 modulators with a simple Adapter. Moreover, it can improve the buffer usage by 20-25% in spite of 2-3% packet overhead. Consequently, it is expected to be the solution of the CAPEX/OPEX costs reduction of the broadcast facilities and equipment and provide new service opportunities to service providers who use multiple media systems for broadcasting.

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