

ROUTE/DASH Server system development for real-time UHD broadcasting

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Abstract— Recently, digital broadcasting has been increasingly demanded for high-definition broadcasting services such as HDR UHDTV. In addition, consumption environment of multimedia is also changing to a tendency to enjoy through various types of terminals. In order to satisfy such changes, we developed a ROUTE/DASH Server system to be inputted real-time encoded UHD stream, packetize it into ROUTE/DASH and output it to UDP, and we also verify it through developed ROUTE/DASH client. The developed ROUTE/DASH Server system provides a way to solve that the limitations of various network and receiving environment of existing MPEG-2 TS system. Using the developed system, it is expected that it can be used not only for multimedia service through broadband but also for transmission system of broadcasting system of ATSC 3.0 in which next standard broadcasting is being standardized.

Keywords— DASH, ROUTE, UHDTV, ATSC 3.0, broadcasting system

I. INTRODUCTION

Currently, digital terrestrial broadcasting in Korea is provided with HD service based on ATSC, the terrestrial digital broadcasting standard of the United States. However, since the MPEG-2 system, which is a transmission standard of ATSC, is intended for transmission of broadcasting media, there is a limits to support both a large capacity high-definition and a new broadcasting environment such as an IP network. In order to solve these problems, MPEG has started to develop new standards for multimedia transmission in the environment of internet. These are based on the provision of segment-based IP services and aim at a method for efficiently transmitting multimedia that in various resolutions and formats by utilizing existing ISO files. These activities established DASH (Dynamic Adaptive Streaming over HTTP) and MMT (MPEG Media Transport) standards, both of which were adopted as transport formats within ATSC 3.0.

In Korea, ATSC 3.0 is adopted as a terrestrial UHDTV standard and adopts both DASH and MMT as a transmission format standard and plans to broadcast in 2017. As mentioned above, DASH is an alternative to MPEG-2 TS, which is established based on the ISO file format. It is designed to cope with various network environment and receiving environment, and has a merit that it is easy to convert between a storage file and a transmission file. In addition, DASH includes a protocol specification called ROUTE (Real-Time Object Delivery over

Unidirectional Transport) for transmission over an IP network, it is possible to replace the MPEG-2 TS in the broadcasting network as well as the broadband network. Above all, in ATSC 3.0 standard, DASH or MMT can be selected in real-time service such as broadcasting, but DASH must be used for non-real-time service such as EPG. However, most broadcasting equipment currently operating in Korea is an MPEG-2 based system and commercial equipment related to ROUTE/DASH is not available in the market, so it is difficult to verify and test related systems. In this paper, we describe that related technology and ROUTE/DASH system developed for UHD real-time broadcasting service.

II. RELATED TECHNOLOGY(ROUTE/DASH)

DASH is an adaptive bitrate streaming format to enable high quality HTTP live streaming of media content over the internet leveraging conventional HTTP servers[1], and is the ISO standard. DASH consists of media segment and MPD (Media Presentation Description) which is metadata describing presentation of media. MPD provides configuration information of the media contents which such as service type, period, media presentation time, URL information, resolution, and bitrate, the media segment is based on the ISO file format and consists of media pieces that divide the actual media data into time units. Figure 1 show media segment structure.

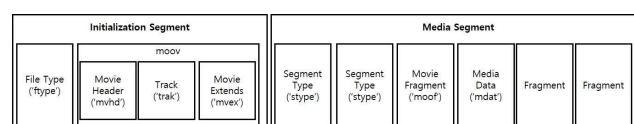


Figure 1. DASH stream structure

In order to play a DASH contents, first, the MPD file is parsed and the included media information is confirmed, the URL information is parsed and access there, and an initialization segment and a media segment are received and played back.

ROUTE is a protocol for file transferring over an IP network developed in FLUTE, which transmits multimedia in LAN and 3GPP environments[2]. ROUTE is based on UDP environment and it is an extension protocol of LCT. Unlike FLUTE, it supports real time transmission of object media and flexible packetization. Moreover ROUTE defines packet format, source protocol (sending/receiving) and repair

protocol. Source protocol and repair protocol operate independently and define ROUTE session and transport session for metadata and object transmission. ROUTE is used for both real-time and non-real-time transmission of the DASH segment in the broadcast network and the receive protocol structure of ROUTE/DASH is shown in Figure 2. In this paper, we have deal with the implementation scope from generation of DASH file to UDP layer in the receiving protocol stack structure.

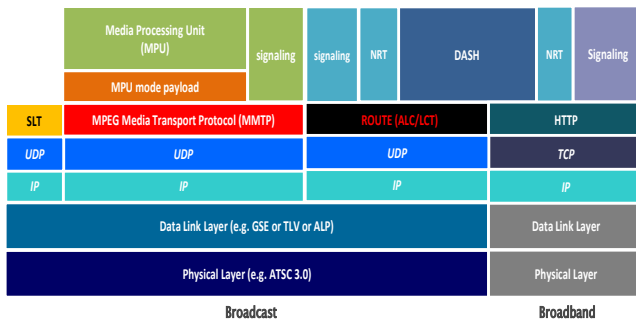


Figure 2. ATSC 3.0 Receiver Protocol Stack

III. THE ROUTE/DASH SERVER SYSTEM

In this section, we describe that ROUTE/DASH server for ATSC 3.0 UHDTV broadcasting service and ROUTE/DASH client for verify it. In this paper, we do not support the whole structure of ATSC 3.0, but the scope of implementation that receives UHDTV contents and packaging it ROUTE packets and transmitted it by UDP and the ROUTE/DASH client receives and playback it. The proposed ROUTE/DASH Server system is constructed as shown in Figure 3.

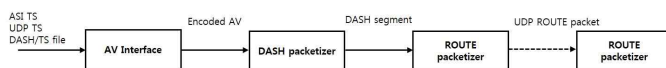


Figure 3. ROUTE/DASH Server system

The ROUTE/DASH Server system includes an AV interface unit for receiving a HEVC/MPEG-H 3DA encoded stream, a DASH packetizer for generating DASH segments by analyzing inputs media, a ROUTE packetizer for converting the generated DASH segments into ROUTE packets for UDP transmission and real-time output.

A. AV Interface unit

The AV Interface unit receives real-time encoded AV data and converts it into a DASH packetizer input format, and supports the following two input modes.

1) DASH/TS file mode

The developed system can operate by inputting the real-time encoded stream, but it is difficult to carry out the test in conjunction with the real-time AV encoder every time it is operated. To solve this problem, our system supports input DASH/TS file which is stored in local storage. Also, when the playback of the stored file is completed and restart is required, presentation time and sequence number of DASH file and

program clock reference (PCR) and continuity counter value of TS are changed according to the current output situation.

2) ASI/UDP TS stream mode

Although the AV interface unit can be directly received HEVC stream data output from the encoder, most commercial encoder equipment does not support HEVC stream output and provides output through the ASI or IP interface in the form of MPEG-2 TS. Therefore, the AV interface unit receives the ASI/UDP TS and extracts the real-time analysis AV according to the time information. In addition, the AV interface unit parses the AV type in TS analysis to determine the media input format of the DASH packetizer and supports the DASH segment packaging operation conforming to the AV type.

B. DASH packetizer

The DASH packetizer performs the function of regenerating the encoded HEVC video and MPEG-H 3DA audio ES received from the AV input unit as a DASH MPD and a media segment. When the DASH segments generation, the size of the segment can be variably set according to the state of the network[3], but the transmission state of the broadcast network is more restricted than the broadband in terms of transmission and delay. In this paper, the compression ratio of HEVC is set to 20~25Mbps, which is the target of most commercial encoders, and the encoding frame rate is set 64 frame per second and IDR frame inserted at intervals of 32 frames. In order to transmit the HEVC stream of the described conditions, the DASH packetizer sets the duration of the DASH segment to 1 second, and performs packetizing to minimize the presentation delay at the DASH client. And the DASH packetizer generates the media segment and updates the MPD in real time as the segment changes.

C. ROUTE packetizer

The ROUTE packetizer receives packetized DASH segments and performs generating ROUTE packets for real-time transmission considering IP environment. The ROUTE stream for transmission consists of service signaling and AV media. In this system, service signaling implements up to SLS for UDP transmission. The ROUTE stream structure in UDP is shown in the Figure 4.

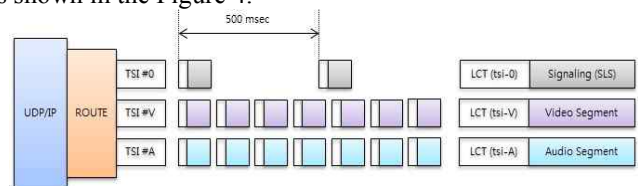


Figure 4. ROUTE packet structure

D. ROUTE/DASH client

To verify the ROUTE/DASH stream signal transmitted in UDP, we have developed a client for ROUTE/DASH Server system. In the ATSC 3.0 environment, the first step is to receive and analyze LLS (Low Level Signaling) and SLS (Service Layer Signaling) when receiving broadcast signals transmitted to the PHY network. However, since the

ROUTE/DASH client does not include the physical layer in the development scope, we uses the LLS file stored in the local storage of the client without receiving the LLS. When playback starts, the DASH client parses the stored LLS information, joins to the ROUTE server multicast address described in the LLS, and acquires the SLS periodically transmitted from the corresponding address. The SLS is a service signaling packet that plays a role of providing transport session information and content information. Since SLS includes MPD information transmitted in real time, it can interpret media information described through MPD file information analysis. And, the S-TSID included in the SLS provides access to the AV packets of the actually transmitted ROUTE stream. Through the analysis of USBD, MPD and S-TSID in the SLS, the actual media packets are assembled and stored on the local disk, and the encoded AV information is transmitted to the media decoder according to the respective DTS information, and the AV decoder decodes it and renders AV on the display & speaker according to the presentation time.

IV. EXPERIMENT & RESULT

The system configuration for ROUTE/DASH consists of HEVC/MPEG-H 3DA encoder for real-time encoded AV input, ROUTE/DASH server and ROUTE/DASH client for receiving and verifying it. Each subsystem uses UDP to transmit data in real-time.

Real-time UHD HEVC and MPEG-H 3D encoders encode raw video/audio into 4K 60P 10 bit HEVC and 16 channel MPEG-H 3DA, respectively, and transmit them to ROUTE/DASH server through UDP network in MPEG-2 TS format. Real-time inputted TS are reassembled into Video and Audio DASH segments, ROUTE packetized, and output to the multicast address through UDP.

As described above, the ROUTE/DASH client analyzes and playback the ROUTE packet transmitted by accessing the multicast address through the LLS interpretation previously stored locally. Figure 5 shows the configuration setting UI of the ROUTE/DASH server system. The ROUTE/DASH server supports various settings for that the bit rate of the incoming TS, the number of ESs to be included in one DASH segment, and ROUTE output. Figure 6 shows the UI for actual ROUTE output according to the configured setting. The developed ROUTE/DASH server can monitoring input/output status such as input TS buffer, DASH segment generation and ROUTE packet output through the status display view of the UI, so that when a packet loss occurs, provides the ability to analyze the problem.

Figure 7 shows ROUTE/DASH client playback operation. The client is consists of packet monitoring window and AV renderer. The monitoring UI can check whether the packets are transmitted correctly by analyzing the current ROUTE packet reception, transmission delay of the video/audio segment transmitted from the server, and segment number information. Figure 7 (a) shows an example of window information in which the packet reception status is displayed. In case of error occurs, analysis information such as packet

loss status and A/V media error is displayed as shown in figure 7 (b). Figure 7 (c) shows an example of receiving content rendering. In the renderer displays the bit rate frame rate, media information, and so on of the currently transmitted media segment on the screen so that the media playback and DASH media configuration information can be grasped.

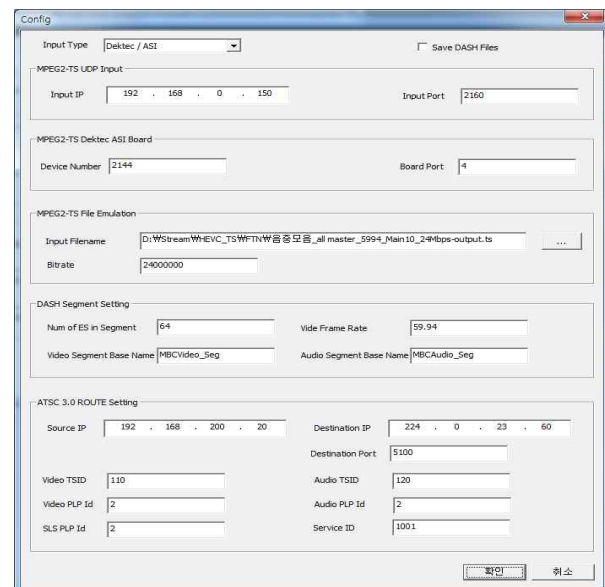


Figure 5. ROUTE/DASH Configuration UI

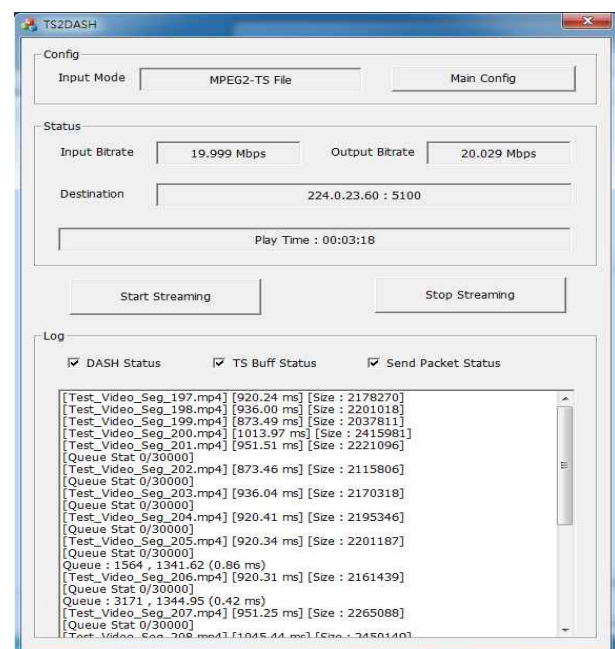


Figure 6. ROUTE/DASH Server UI

In order to secure the data transmission, the network configuration of this system was experimented through an internal network configuration using a switching hub. Experimental results reported that ROUTE/DASH based on IP environment is more sensitive to the fluctuation of media bit rate than MPEG-2 TS transmission method, so that precise rate control of encoder is required to prevent packet loss, and

broadcasting equipment for actual service is very poor. Moreover, since existing broadcasting equipment mostly consider MPEG-2 environment, it is difficult to verify the stability of broadcasting transmission system through IP network. In the future, it is expected that it will be possible to use the developed system in real-time UHDTV broadcasting system based on ATSC 3.0 in the situation where commercial ROUTE/DASH related products are insufficient.

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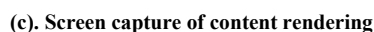
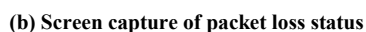
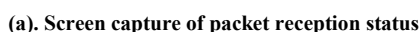


Figure 7. ROUTE/DASH client

In this paper, we propose ROUTE/DASH Server system for 4K UHDTV broadcasting. The proposed system is designed to interoperate with the conventional commercial AV encoder and implemented to generate ROUTE/DASH packets in real time by receiving encoded AV. Korea's UHD broadcasting service based on ATSC 3.0 is in the face, but preparation of

