Hybrid Media Transport System

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***Abstract* — The hybrid era integrating broadcasting and broadband is upon us, in which it is one of challenge issues how to synchronize broadcasting services with the Internet applications under the hybrid network environment. The related technologies and standards have been developed by major broadcasters and international standardzation organizations. This paper gives a description of requirements, architecture, and some service examples of the hybrid media transport system.**

***Keywords*— MPEG-2 TS, DASH, H.264/AVC, SVC, Hybrid Media**

I. Introduction

A hybrid media transport technology is widely emerged as the important technology for enhanced broadcasting services, in which both broadcast and broadband techniques are interworked and used in the whole process of content creation, transport, and consumption.

Hybrid Broadcast Broadband TV (HbbTV) for hybrid TV has been standardized by European Telecommunications Standards Institute. It is focused on establishing an open and Web based middleware platform to provide a seamless Web-based interface for the integration of broadcast and broadband content [1]. Advanced Television Systems Committee (ATSC) 3.0 has been developing the standard for Service Compatible Hybrid Delivery 3D using Broadband [2]. Nippon Hoso Kyokai (NHK), Japanese Broadcasting Corporation, is also developing its platform called Hybridcast to enhance broadcasting services. Hybridcast is not only the broadcast and broadband integrated platform for Web-enable application but also the hybrid broadcasting platform for new various features and services. Open Hybrid TV (OHTV) in Korea is the standard for the hybrid TV's service specification, which integrates the broadcast with the broadband. Its hybrid media service platform has been developing according to the specification for high value-added media services.

This paper introduces the hybrid media transport system detailed its requirements in the chapter II, architecture in the chapter III, and service scenario and applications in chapter IV.

II. Hybrid Media Transport Requirements

Figure 1 shows the concept of the hybrid media transport system under the heterogeneous network environment.

It is possible to provide a variety of broadcasting service quality depending on Internet channel resource while offering basic broadcasting services over a broadcasting network. The converged broadcasting and broadband technologies of a network, content, and terminal make it possible to provide bidirectional personalized services. With compliance to terminal and network specification, the much more flexible and adaptive content delivery is possible for optimal quality guarantee services.

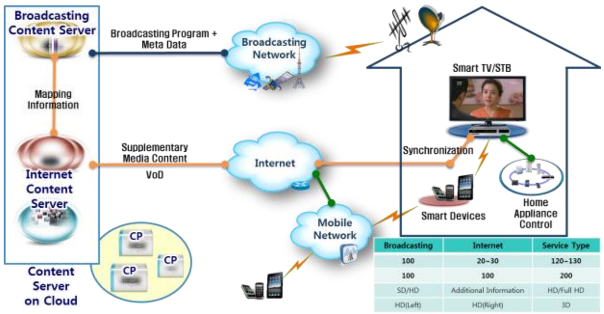

Figure 1. Concept of Hybrid Media Transport System[3]

Major requirements are as follows:

(1) A server and client have more than two different kinds of connections at minimum.
(2) Multilayer encoded video has to be transported using both MPEG-2 TS via a broadcasting network and HTTP via Internet as well.
(3) Seamless services have to be offered using a base layer of multilayer encoded video even though the Internet transport quality is temporarily deteriorated.
(4) A multi-layered video received from a hybrid network should be synchronized and displayed at a terminal.
(5) A terminal can display HD/Full HD/3D or replay a TV's previous HD according to a viewer's selection of a terminal UI.

The hybrid media transport system uses two important technologies: one is MPEG's Scalable Video Coding (SVC) and the other is MPEG's Dynamic Adaptive Streaming over HTTP (DASH).

SVC provides to represent different video versions with different frame rates, spatial resolutions or quality levels by a single video stream. A SVC stream consists of a base layer and one or more enhancement layers. The base layer corresponds to the lowest frame rate, spatial resolution and quality. The resulting decoded video is enhanced in any of the aforementioned dimensions by adding enhancement layers.

DASH was mainly proposed by major players like Adobe Systems, Apple, and Microsoft. DASH has the characteristics of a variable bandwidth adaptation. DASH makes it possible to transport a high resolution video data when the bandwidth is enough; otherwise, it transports a low resolution video data. Therefore, DASH can transmit seamlessly any video data over Internet [4].

III. HYBRID MEDIA TRANSPORT System

Figure 2 shows the hybrid media transport system as a server and client model.

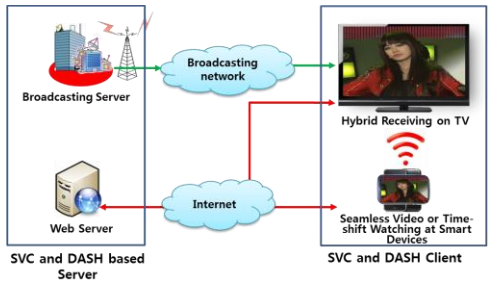

Figure 2. Overal Struture of Hybrid Media Transport System

The hybrid media transport system is configured with a broadcasting server and a Web server as a SVC and DASH server, and a TV and a smart device as a client. A server and client is interconnected by both a broadcasting network and Internet. The system provides hybrid media services such as SD, HD/Full HD media service, 2D/3D media service, and time shift service.

Figure 3 shows a SVC based streaming server that has several functional modules, which are a File Reader, MPEG-2 TS DeMuxer, MPEG-2 TS Segmenter, MPD Generator, MPD Generator, Web Server, and TS Muxer & Broadcasting Transformation.

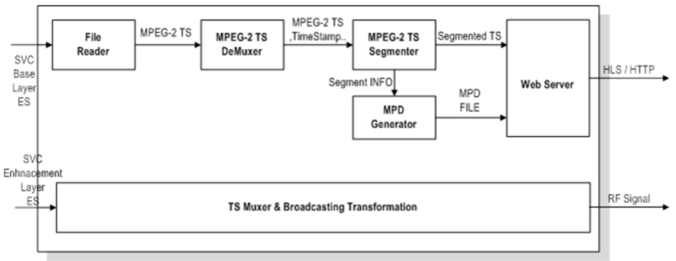

Figure 3. SVC based Streaming Server

The File Reader module is responsible for reading, multiplexing a selected layered video Elementary Stream (ES) into MPEG-2 Transport Stream (TS) and storing a selected layer in a file format after it receives an AC-3 audio ES file and a SVC video ES file. In particular, it multiplexes a SVC video and AC-3 audio into MPEG-2 TS to be compliant to ISO/IEC 138181-1 specification. The MPEG-2 TS Demuxer sends Presentation Time Stamp (PTS) information to the MPEG-2 TS Segmenter module, in which the received TS stream is parsed, and segmented. The MPEG-2 TS Segmenter generates a DASH's segmented TS file based on a received MPEG-2 TS file. It makes a chunk sized TS file from each received layer video data to meet a user's requirement. It also sends the MPD Generator the information so that the MPD Generator module can use it how to segment the received layer video data. The MPD Generator generates a MPD file using encoding parameters and the information received from the MPEG-2 TS Segmenter module.

The Web server uses Apache Tomcat Server 7.0 for DASH segment services, which supports HTTP/1.1 GET and byte range access specified in the DASH specification. It stores a segmented TS and MPD files into Tomcat HTTP server's service directory to be accessible using HTTP.

TS Muxer & Broadcasting Transformation reads the enhancement layer video stream, multiplexes it, transforms it to a QAM signal, and send the signal to the client.

Meanwhile, Figure 4 shows a SVC based DASH client which is composed of two modules, a HTTP interface and a DASH client.

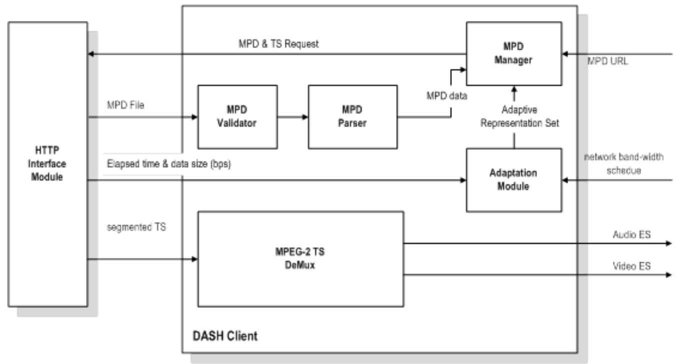

Figure 4. SVC based DASH Client

The HTTP Interface module supports HTTP get 1.1, segmentation and streaming functions. It requests a MPD file and a segmented file, and streams it.

The MPD Validator is the module to validate a MPD XML document using a MPD schema specified at MPEG DASH ISO/IEC DIS 23009-1. In the validation of a MPD XML document, two aspects are treated, syntax and semantics. A syntax validation is done using a XML parser's tool, and a semantic validation is to confirm whether each MPD element and attribute is used properly in a MPD document. The MPD Parser parses a MPD element and attribute, and it sets its parse context into a data class of MPD information.

The MPD Manager receives a media segment TS using a MPD data, transports it to the MPEG-2 TS DeMux. The Adaptation Module supports to be capable of adaptively receiving a variable data to the current available bandwidth.

The MPEG-2 TS DeMuxing is the module to receive a Transport Stream (TS) of a 188 byte sized transport packet and to produce an audio and video with a Presentation Time Stamp (PTS).

The DASH receiver requests a segmented TS file to the server via the HTTP interface, which is proper to a transport bandwidth. It receives the TS, separates an audio ES and a SVC based video ES via the TS-DeMuxer, and decodes them. The separated layered video ES is unified into one video in accordance with the decoded sequence.

One of the most striking features is known as a content synchronization method over different networks. Figure 5 depicts synchronization processing between a TV and smart device. Network Time Protocol (NTP) is used to establish the same wall clock of a TV and a smart device, and to estimate the PTS value by compensating a processing and network transmission delay. A TV gets a PTS (T1) because of a transmission delay from a smart device to a TV even though a smart device requests a T0 PTS value to a TV. A smart device receives PTS (T1) at T3 from a TV because of TV's processing delay and a transmission delay from a TV to a smart device. A smart device can estimate its PTS value using a TV's PTS (T1) and T3 [5].

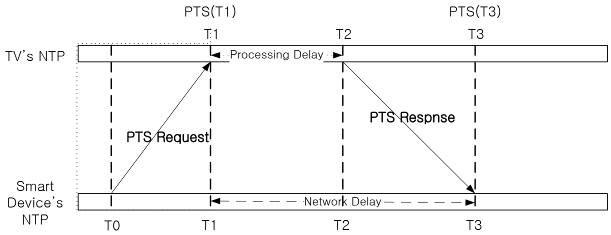

Figure 5. Synchronization Processing between TV and Smart Device

IV. Hybrid Media Service

The service scenario procedure is as follows:

(1) The standard, high density (SD/HD) or 2D video servic es is played on TV using a broadcasting network.

(2) The full high density (Full HD) or 3D video service is provided on TV when a viewer prefers to watch it. Thi s service is offered by adding and activating Internet to get enhancement layer video and synchronizing a base l ayer video with an enhancement layer video.

(3) A time shift service is provided on a smart device, whic h is the SD or HD video service to be previously displa yed on a TV.

(4) The dynamic adaptive video service is played on TV in case that an Internet bandwidth is temporarily changed.

A. SD, HD/Full HD Media Service

A user watches a SD or HD video program by SVC's base layer transported through a broadcasting network. An additional video data, an SVC enhancement to make a Full HD video program, is transported through Internet.

A SVC's base layer is transported using MPEG-2 TS via a broadcasting network, and an SVC enhancement using RTP via Internet. A client receives these two layer video, synchronizes, and let a user to be able to watch a full HD video program. Figure 6 shows the SD, HD/Full HD hybrid media transport scheme.

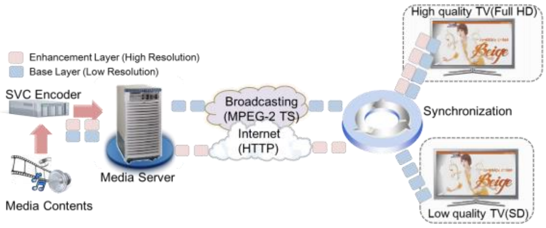

Figure 6. Concept of HD/Full HD Hybrid Media Transport

Figure 7 demonstrates a full HD service working on our hybrid media transport system. Thanks to DASH, a seamless optimal quality service can be provided, which its quality is depended on the Internet's variable bandwidth.

Figure 7. Hybrid HD/Full HD Service

B. 2D/3D Media Service

Figure 8 shows the 2D/3D hybrid media transport scheme. A 2D video using a SVC's base layer is transported through a broadcasting network. An additional video data, an SVC enhancement to make a 3D video program, is transported through Internet. A client receives these two layer video, synchronizes them, and allows a user to watch a 3D video.

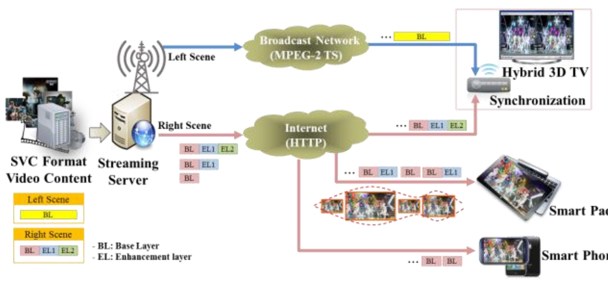

Figure 8. 2D/3D Hybrid Media Transport

Figure 9 is the demonstration result of a hybrid 2D/3D service on a hybrid media transport system. A 2D video, a left side of 3D is transported via MPEG-2 TS of a broadcasting network and a right side of 3D is transported using HTTP via Internet. Thanks to DASH, an optimal quality multiscreen service is available to smart devices.

Figure 9. Hybrid 2D/3D Service

C. Time Shift Media Service

A time shifting is to record live TV program to a storage medium to be viewed or listened to a user at any convenient time. In particular, the time-shift service of the hybrid media transport system is based on hard drives located in the service provider domain. This mechanism is needed if the local hard drive is limited to such as smart devices.

Figure 10 shows the overall interface between a server and a client to offer a time shift service. A user is able to recognize a time shift service via a TV's UI while watching the live TV program. To do this, a TV STB parses a metadata of the live TV program, sends its results to a smart device, and gives a notification to a user via a TV's UI that a time shift service is able to be provisioned to a user. That is, a smart device receives the time line synchronisation information and the Internet server's URL indicating the location information of live and time shift media from a TV STB. A time shift server sends the stored time shift content of a specific time which a user wants to watch when a user requests a time shift service using a smart device's UI. A smart device displays time shift contents synchronized with a TV program in compliance with a live Internet server's DASH MPD. When a user finishes a time shift service using UI, a smart device resumes to its multiscreen service state.

V. CONCLUSIONS

This paper introduced the concept of hybrid media transport system and its research activities of major broadcaster and standard bodies. The hybrid media transport system was described in the details including requirements, architecture, service scenarios, and has been implemented currently by the service demonstration level except time shift service.

The described hybrid media transport system may be available for hybrid broadcast services and multiscreen services as well. For richer, more informative and tailored hybrid broadcast services, the more research on smart hybrid feature and core technologies are needed, in particular cloud computing, dynamic streaming, and HTML5 areas rather than integrating a broadcasting and Internet area.

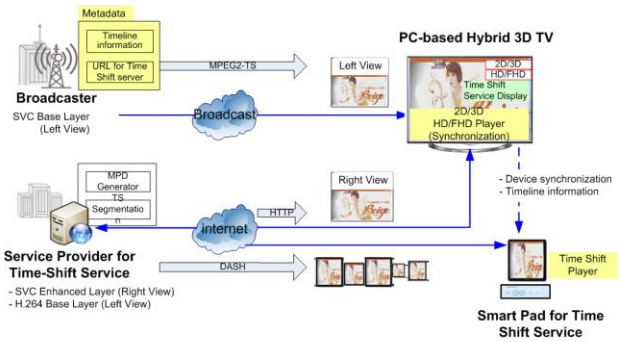

Figure 10. Time Shift Media Transport

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