VOD Technology for Next-generation IPTV

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Abstract

As video-on-demand technology for next-generation IPTV, we introduce a content format that conforms to broadcasting standards, a forward error correction method for IPTV, and a playback control method that works in conjunction with a playback control file to allow program playback according to the content and the user.

1. Introduction

In the last few years, with the expanding popularity of broadband networks and terrestrial digital broadcasting, there has been vigorous activity in the provision of video-on-demand (VOD) service to TV sets connected to broadband networks as well as to personal computers. This is known as IPTV (Internet protocol television). Various providers are starting services to televisions connected to set-top boxes (STBs) and the establishment of standard specifications for IPTV is progressing.

These days, most homes have a TV, and watching television is a familiar daily activity in our lives. Therefore, we can expect broadband services to expand even further if we provide an environment that allows VOD content to be offered over a broadband network to be viewed in the same familiar way as programs offered by broadcasting. Nevertheless, TV sets differ from personal computers, which have adequate machine resources and can easily run the required application programs. Functions for connecting to a broadband network and enabling users to view VOD must be implemented with the limited machine resources of a TV set. A further constraint is that those functions must coexist with the functions for receiving broadcasting so that the same receiver can be used for both broadcasting services and IPTV VOD. We believe that maintaining a quality that is not inferior to digital broadcasting while coping with such constraints and providing services that could not been implemented in the past by only broadcasting is the challenge in providing VOD service for IPTV.

In this article, we outline a system for providing VOD service for IPTV and explain technologies for delivering content, limiting packet loss on the network, and controlling content playback. We also introduce advanced technology that NTT Cyber Solutions Laboratories is investigating.

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2. VOD system for IPTV

2.1 System overview

A system configuration that serves as an environment for providing VOD service for IPTV is illustrated in **Fig. 1**. The actual configuration also has a system for cooperation with other servers and a system for operation and management in service provision. These have been omitted from the figure for simplicity.

The IPTV receiver is assumed to be connected to a content delivery network (CDN) or other such IP network. It communicates by IPv6 (Internet protocol version 6) with the various servers that are involved in

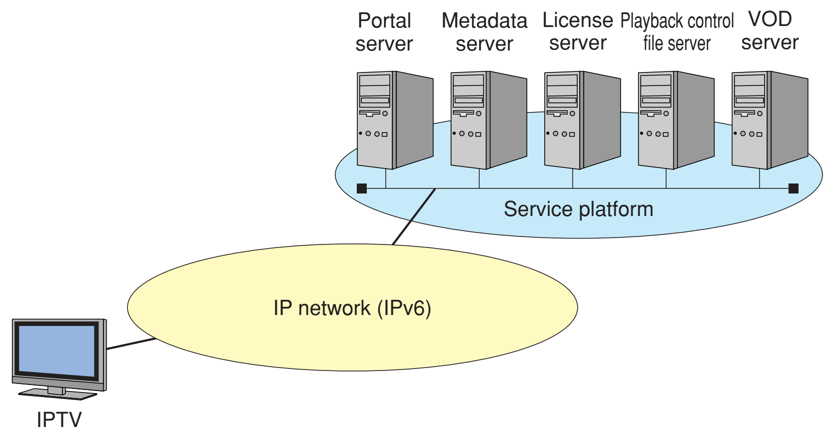

Fig. 1. VOD service provision environment for IPTV.

providing the VOD service on a service platform that is connected to the same network.

As facilities on the service platform side, the portal server and the metadata server provide the user with content information and a user interface for content playback. The license server cooperates with license-related functions inside the receiver to control content decoding according to the conditions for using the content. The playback control file server supplies the information that is required for playback before the content is played. The VOD server supplies the content in the form of a video data stream according to requests from the receiver.

2.2 Content formats

The formats that are being studied for application to VOD content for IPTV include MPEG-2, which is the main format that has been used so far in digital broadcasting and VOD services, and H.264, which is a highly efficient compression encoding for high-quality video.

MPEG-2 transport stream (TS) packets carry content encoded by either MPEG-2 or H.264. For storage and viewing in digital broadcasting, the standard specifies that in Japan a four-byte timestamp should be appended to each of these 188-byte MPEG-2 TS packets to form a timestamped transport stream (TTS) of 192-byte packets. This TTS format is used for VOD for IPTV as well.

In the original MPEG-2 TS, timestamping with a 27-MHz clock is done when the data is encoded so that the data can be input to the decoder on the receiver side in the proper order, even if the packet arrival order is disrupted by delays or fluctuations in network transport. The TS packets are decoded and played back according to their timestamp values. The limited resources available to a TV set mean that the buffer for this decoding timing is not large enough to receive and play back long programs. However, the timestamp can be further used to control the input to the decoder to prevent buffer overflow due to transmission delays and fluctuations in the playback of long programs.

2.3 Forward error correction

In the transport of packets over a network, errors may occur on the transmission path or packet loss may occur due to buffer overflow in a network device. Packet loss is directly linked to a decrease in the quality of the video distribution service, so countermeasures are required. Forward error correction (FEC) is one technique for restoring lost packets at the receiving side.

We compared various FEC methods (such as LDPC, Reed-Solomon, and Hamming) in terms of computation cost, performance, and openness of the specifications. As a result, we chose to use one-dimensional Pro-MPEG FEC [1] because it (1) involves lightweight parity computations that can be handled by the types of CPU installed in TVs and STBs, (2) is robust against continuous packet loss, and (3) has free and open specifications published by the Pro-MPEG Forum. This method involves arranging packets in an array and performing parity calculations in the vertical direction to generate FEC packets (**Fig. 2**), thus producing an effect equivalent to interleaving and achieving robustness against continuous packet loss. The one-dimensional scheme cannot restore packet loss that is continuous in the vertical direction in the array, so specifications for two-dimensional Pro-MPEG, which also performs parity checking horizontally, have also been published.

NTT Cyber Solutions Laboratories is developing a high-speed Pro-MPEG FEC realtime encoder that can process tens of VOD streams and work on an IPv6 network. We are asking receiver manufacturers to incorporate the decoder with the objective of improving the quality of the video distribution service.

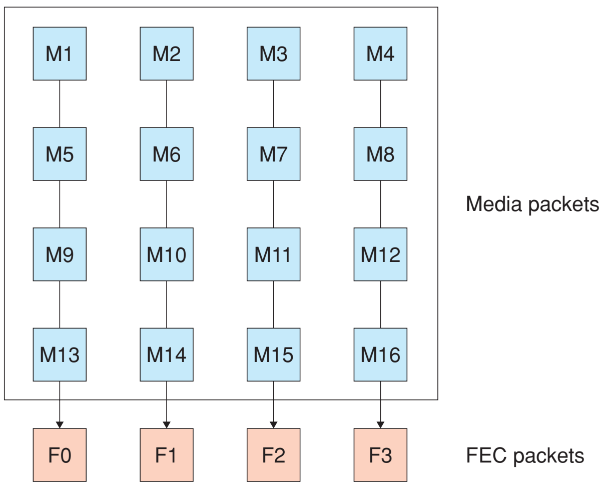

Fig. 2. FEC method for IPTV.

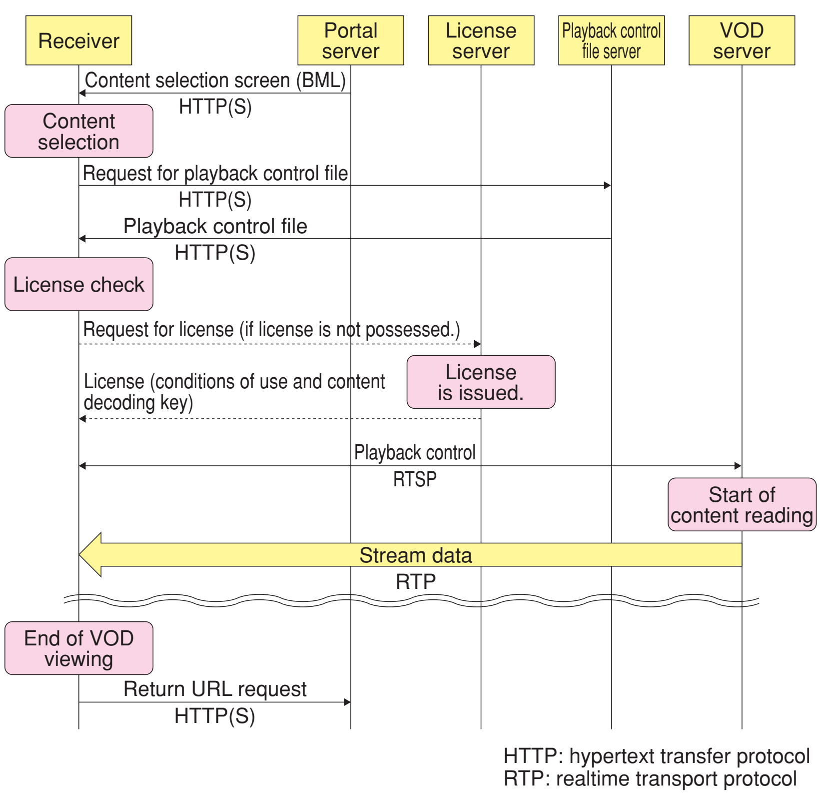

Fig. 3. Basic sequence of VOD.

2.4 Content playback control

The basic playback sequence of the VOD service for IPTV that we are studying is shown in **Fig. 3**. To use the VOD service, the user selects the desired content from either a portal screen that is generated from broadcast markup language (BML) supplied by the portal server or an electronic content guide (ECG) generated on the receiver side from metadata provided by the metadata server.

Before the playback request is sent to the VOD server, the playback control file is obtained. This file contains the destination of the content request to the VOD server and the information required to play back the content according to the user and the content.

After the receiver gets the playback control file, a content license (the conditions of use and decoding key for the content) is retrieved from the license server if necessary, and the content delivery request is sent to the VOD server URL (uniform resource locator) specified in the playback control file.

The distribution from the VOD server is controlled using RTSP (realtime streaming protocol). This protocol is now in general use for controlling streaming playback (stopping or pausing and fast forwarding or rewinding) in VOD, etc. RTSP was jointly established by RealNetworks, Netscape Communications, and Columbia University in 1998 and has been put forward as Recommendation RFC2326 by IETF [2]. We referred to the RTSP specifications that have been studied or implemented so far and are using them for IPTV, but with a narrower implementation range and a few extensions.

In our method, RTSP-based distribution control and the playback control information in the playback control file work together to implement content use that is based on the characteristics of the requested content itself and the user.

The information in the playback control file is organized into units according to the purpose of playing back the requested content and control of that playback, rights protection, and playback conditions specific to the viewing user, as described below. Each of these units of information is an XML file, and the files are provided collectively for the receiver to refer to as necessary.

1) Content-specific information: Destination for the content delivery request, encryption status, chapter information, etc.
2) Content playback control information: The type and speed of playback functions (fast-forward, rewind, etc.) supported by the VOD server
3) Information concerning the protection of rights related to the content: The information required to obtain a license, etc.
4) Information related to content playback specific to the user: The playback starting position for the individual user

This information serves as the basis for obtaining license and playback control by RTSP by the receiver.

Here, we present two examples of VOD functions implemented through cooperation between the playback control file and RTSP.

(1) Resume function

The resume function allows the user to interrupt the VOD content during playback and restart later from the same position. This function differs from pausing the program while it is being viewed because the viewing session is actually terminated. This resume function needs to bookmark the stopping position until playback is resumed. This information can be either stored locally by the receiver or sent to a portal server or other server to be stored together with user information and managed on the service platform side. The former method is limited by the receiver's resources for storing information. Moreover, it means that the user cannot resume playback from a different receiver, e.g., one in another room. Therefore, we chose to manage bookmarks on the service platform side. The portal server and the playback control file server cooperate so that when the playback control file is retrieved, the information of the user that made the program playback request is obtained. The program stopping position is set in the user-specific information in the playback control file and is thus provided to the receiver. The receiver refers to that bookmark and sends a request to the VOD server for playback from that position by RTSP. In this way, playback is resumed.

(2) Chapter playback function

The beginning points of program chapters (divisions within the content of the program) can be set in the playback control file information. The user can select the desired chapter on the receiver, which then sends a request for playback from the beginning of the specified chapter to the VOD server by RTSP. Then playback begins.

3. Future development

NTT Cyber Solutions Laboratories is testing the basic technology for providing VOD service for IPTV described above and conducting R&D on even more advanced technology, such as that shown in **Fig. 4**. Network digital recorders (NDRs) will allow users to view programs that were missed at the time of broadcast at a later time by VOD via an IP broadcasting system. Technology for cooperation between VOD and mobile terminals will make it possible to provide content-related information and advertisements to a mobile terminal in real time synchronized with the content of the VOD program being viewed according to user attributes in RTSP session information. That information will increase the user's under-

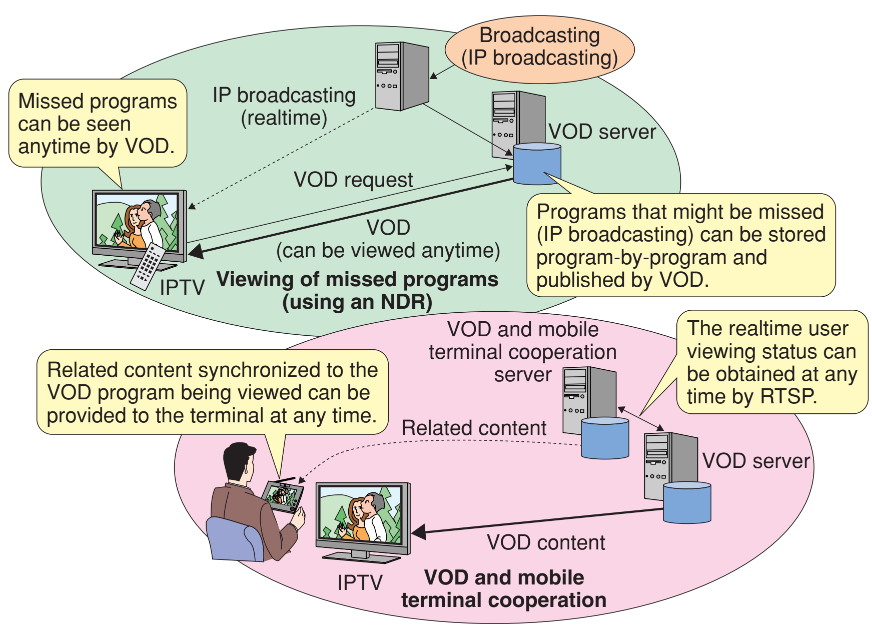

Fig. 4. Technology for advanced VOD.

standing of and interest in the content and provide opportunities for the user to order commercial products related to the content immediately. Through this research and development, we hope to increase the popularity of digital content distribution in the era of fusion between communications and broadcasting.

References

[1] http://www.magellan-itea.org/docs/publications/Vid-on-IP-CoP3-r2.pdf

[2] http://www.ietf.org/rfc/rfc2326.txt

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