IP Broadcasting Technology for Next-generation IPTV

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Abstract

We describe the next-generation IP (Internet protocol) broadcasting system and lightweight IP broadcasting technology for implementing it in an economical and general manner. This technology combines broadcasting system processing such as transport stream multiplexing and service information distribution processing with IP network transmission processing to achieve economy and allow general transmission processing, regardless of whether service information is multiplexed in the input video source data or not.

1. Introduction

With the spread of broadband IP (Internet protocol) network services and the development of encoding technology such as H.264/AVC, we have recently had a true taste of the stable broadcasting of high-quality video over an IP network (IP broadcasting service). The benefit for the user is the easy reception of many video programs because IP broadcasting services can make use of the expanding IP infrastructure. We also believe that sharing a common transmission infrastructure with video-on-demand (VOD) and other communication services will further the cooperation between broadcasting and communications on the service and application levels so that even more appealing services will become available [1].

In Japan, satellite digital broadcasting began in 2000 and terrestrial digital broadcasting began in 2003. These digital broadcasting systems provide a data broadcasting service by means of the broadcast markup language (BML) and an electronic program guide (EPG) service by means of service information (SI) in addition to the video and audio content provided by conventional analog broadcasting. From the viewpoints of service guarantee to the viewer and reduction of the cost of providing receivers, it is important to provide programs via IP broadcasting services by means of a system that conforms as much as possible to standard digital broadcasting systems.

In this article, we describe a typical example of a next-generation IP broadcasting system that is highly compatible with standard digital broadcasting systems. We also explain IP broadcasting technology for general and economical implementation of that system.

2. Next-generation IP broadcasting system

The concept of IP broadcasting is illustrated in **Fig. 1**. Programs are distributed from transmission facilities by IP multicasting. At the receiver, the user selects a channel and the multicast stream carrying the selected program is received and played back.

Some typical specifications for the next-generation IP broadcasting system are listed in **Table 1**. This system is based on standard digital broadcasting with the addition of items required specifically for delivering digital broadcasting programs over an IP network. The protocol stack for the IP broadcasting system, which delivers a data stream by multicasting, is

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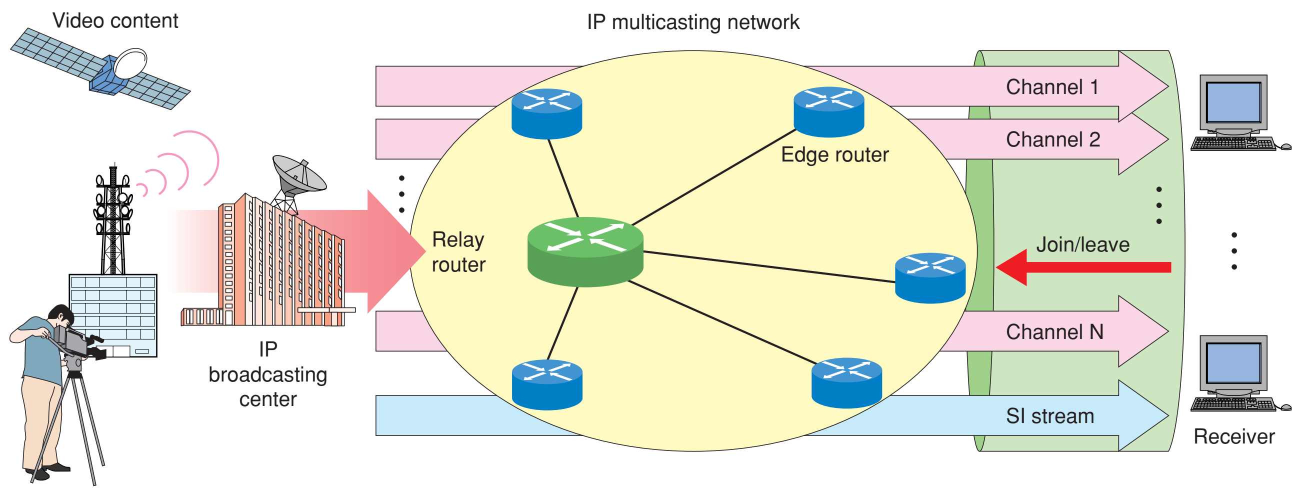

Fig. 1. Concept of next-generation IP broadcasting.

Table 1. IP broadcasting system specifications.

Video formats	480i, 480p, 720p, 1080i
Video encoding	MPEG-2 video, H.264/AVC
Audio encoding	MPEG-2 AAC, MPEG-1 Layer 2
Multiplexing	MPEG-2 systems
SI encoding	Program schedule information based on the ARIB-B10 specification
Transmission protocol	RTP/UDP/IPv6
Channel selection protocol	MLD
Replay timing control	Timestamped transport stream method
Error correction	ProMPEG FEC

AAC: advanced audio coding
RTP: realtime transport protocol
UDP: user datagram protocol
MLD: multicast listener discovery
FEC: forward error correction

shown in **Fig. 2**. The stream is first multiplexed at the transport stream (TS) packet level in the same way as for digital broadcasting and then wrapped in IP packets. Technical features specific to IP broadcasting are explained below.

2.1 TTS-based playback timing control

The format for storage and playback used in this system is the timestamped transport stream (TTS) format specified in the second edition of ARIB STD-B24. It appends four bytes of timestamp information (a 27-MHz counter value) to each 188-byte TS packet. The receiver uses this timestamp to control the timing of the TS packet input to the decoder. That makes it possible to appropriately compensate for packet delay on the IP network and ensure correct replay of the video.

2.2 SI transmission in a dedicated channel

Digital broadcasting specifies control and attribute information for programs. This service information (SI) is multiplexed in with the program itself and can be used to control the receiver or to display a description of the program, etc. Typical SI items for IP broadcasting are summarized in **Table 2**. The event information table (EIT) provides the program title, a description of the program, broadcast time, and other attributes, so the amount of data increases with the number of programs. There are two kinds of EITs: EIT[p/f] holds information only about the current program and the next program for distribution and synchronization. EIT[schedule] holds program information for a certain number of days. If the EITs for all channels were delivered on each channel, as in satellite digital broadcasting, the amount of data transferred would be even greater. If the EIT for the programs broadcast on a particular channel were delivered only on that channel, as in terrestrial digital broadcasting, then the amount of transmitted data could be reduced to some extent, but frequent joining and leaving of multicasts on the receiver side to obtain the EIT of other channels would create a congestion problem. Our system resolves this problem by collecting together some of the SI for all of the channels at the sending side and transmitting that SI on a single multicast stream dedicated to SI. The collected data is mainly the EIT[schedule] information.

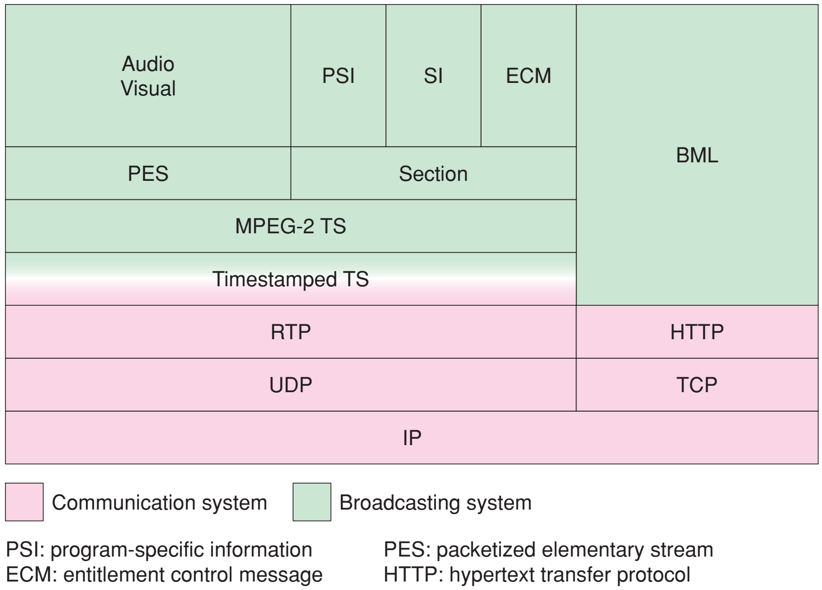

Fig. 2. Protocol stack for the IP broadcasting system.

Table 2. Service information for IP broadcasting.

Table	Contents
Network information table (NIT)	Network information such as multicasting addresses and information related to the schedule channel
Service description table (SDT)	Service-related information such as the channel name and IP broadcaster's name
Broadcaster information table (BIT)	Information about the IP broadcaster
Event information table (EIT)	Information about the program, such as the program title, broadcast date and time, and program description

It is large in volume, but does not require tight synchronization with the programs.

2.3 Distribution of channel selection information over a network

As mentioned above, the receiver must know the correspondence between each channel and the IP multicast stream in order to receive and play the selected channel. Conventionally, in digital broadcasting and CATV (cable TV) specifications, the network information table (NIT) contains the frequency, modulation scheme, channel's physical location, and other such information for use in demodulation according to the channel selection. Therefore, in our system, too, the NIT descriptors are extended to include IP multicast stream location information (address, port number, etc.) and distributed as network channel selection information. The receiver can thus know the correspondence between the IP broadcasting channel on which the service is provided and the physical stream location. In addition to multicasting location information, the NIT can also hold parameter information that can be used for forward error correction in IP transport.

3. Lightweight IP broadcasting technology

3.1 Overview

As one aspect of achieving a high degree of compatibility with digital broadcasting systems, the next-generation IP broadcasting system must output data streams that conform to broadcasting system specifications. This is a feature that is not provided by conventional communication system services that distribute video. Configuring the system to implement the processing for streaming output as dedicated

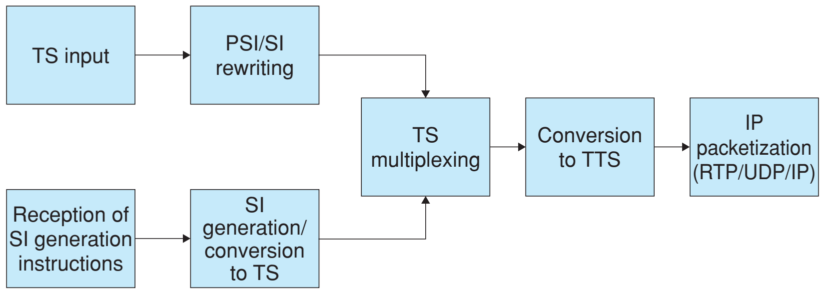

Fig. 3. Processing flow in the program server.

hardware, however, would increase the cost of service provision.

NTT Cyber Solutions Laboratories is conducting research and development on lightweight IP broadcasting technology for low-cost implementation of next-generation IP broadcasting service transmission. To reduce the transmission cost and increase service operability, it uses 1) integrated transmission processing that allows all processing for IP broadcasting transmission to be executed on a general-purpose server and 2) general transmission processing that does not depend on the SI multiplexing condition of the input video stream.

The processing flow of a program server with this technology is shown in **Fig. 3**. The broadcasting system processing consists of TS multiplexing processing and PSI/SI processing for generating a data stream that conforms to broadcasting system specifications (PSI: program-specific information). Communication system processing consists of conversion to a TTS and IP packetization for streaming to the IP network. Both types of processing can be implemented on a single general-purpose server.

Assuming that various kinds of video content will be provided by IP broadcasting services in the future, the video source material that is input to IP broadcasting facilities will include both SI-multiplexed material that conforms to broadcasting system specifications and non-SI-multiplexed material. The lightweight IP broadcasting technology enables a next-generation IP broadcasting system to transmit programs regardless of such differences in input source data. Specifically, if SI is not multiplexed into the input source data, external information in CSV (comma separated values) format or another general-purpose format can be input and multiplexed with the program or transmitted as a dedicated SI stream. If SI has been multiplexed into the input source data, that information can be used for automatic generation of a dedicated SI stream or for other purposes.

3.2 System configuration

The configuration of the implemented lightweight IP broadcasting system is illustrated in **Fig. 4**. This system comprises SI transmission management servers, program servers, and dedicated SI servers. The SI transmission management servers manage and control the output of the NIT, service description table (SDT), broadcaster information table (BIT), and EIT data. The program servers deliver programs that consist of video, audio, and subtitle data together with SI for multiplexing into the program by IPv6 multicasting. The dedicated SI server reconstructs the SI sent to it from a program server or SI transmission management server into a dedicated SI stream and transmits it by IPv6 multicasting.

An example illustrating the transmission processing when the input sources are channel α, which has EIT, and channel β, which does not have EIT, is shown in Fig. 4. In the transmission processing for channel α, the data other than the EIT[schedule] is IP packetized and transmitted by the program server. The dedicated SI server reconstructs the EIT[schedule] data that was separated or extracted and sent to it by the program server and then transmits that data. In the transmission processing for channel β, the SI transmission management server sends SI transmission instructions that are based on information obtained externally to both the program server and the dedicated SI server. The program server multiplexes the SI with the program for transmission and the dedicated SI stream reconstructs the SI for transmission. This system thus achieves economy and generality in the transmission processing for IP broadcasting.

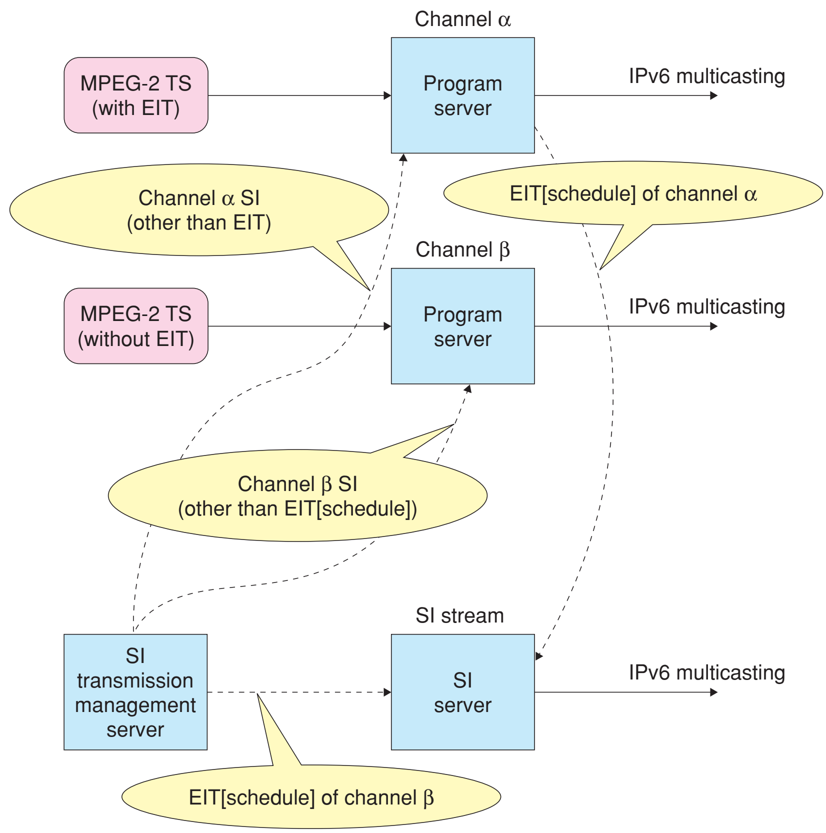

Fig. 4. IP broadcasting system.

4. Future Work

We plan to investigate a conditional access system for content protection and access control and achieve cooperation with external systems such as H.264/AVC transcoders. We will also continue with research and development toward achieving next-generation IP broadcasting services of even higher quality and stability.

Reference

[1] T. Yamaguchi, H. Matsumura, and K. Kawazoe, "Service control method for cooperation of broadcasting and communications using metadata," ITE, Vol. 60, No. 2, pp. 200-209, 2006 (in Japanese).

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