

## Distribution Control Technology Using Metadata for Cooperative Broadcasting and Communication Services

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### Abstract

We describe technology for integrated management and control of various kinds of content distribution, such as realtime broadcasting, broadcasting based on home servers, video on demand, and file downloading, by using metadata that describes distribution control conditions in addition to content metadata (conforming to the TV-Anytime Forum specifications).

### 1. Introduction

With satellite and terrestrial digital broadcasting services beginning in recent years, there has been a steady advancement in broadcasting services. Digital broadcasting services provide new high-value-added services such as data broadcasting using a multimedia data coding system (e.g., BML (broadcast markup language) in Japan) and electronic program guide (EPG) services using service information (SI) in addition to the video and audio provided by conventional analog broadcasting. Furthermore, specifications are being set for broadcasting based on home servers (broadcasting services using storage devices) as the next wave of services that employ metadata.

The distribution control technology using metadata for cooperative broadcasting and communication services described here makes maximum use of bidirectional, high-speed broadband communication to support integrated distribution of content via multiple forms of services, including 1) realtime broadcasting (using radio frequency (RF)), 2) realtime broadcasting (using IP (Internet protocol) multicasting), 3) broadcasting based on home servers (RF), 4) broadcasting based on home servers (IP multicasting), 5) video on demand (VOD), and 6) file downloading services. This approach increases the opportunities

for providing and using content and expands profitability through the principle of one source, multiple uses. Furthermore, combining push- and pull-type\*<sup>1</sup> metadata distribution allows finer content searching and filtering and advanced viewing services in which particular scenes can be replayed, etc.

Until now, there was no research on integrating program distribution for broadcasting and communications media. Moreover, there was no technology or systems that could distribute programs efficiently by reflecting the intention of content providers as metadata. The technology described here makes possible systematic operation and management of all services in a cooperative broadcasting and communication system through the use of metadata.

### 2. Main functions

This distribution control technology consists of four functions (Fig. 1).

#### (1) Content and metadata management

This function manages the content and content metadata (conforming to TV-Anytime Forum SP003) resources provided by the content provider.

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\*<sup>1</sup> push-type and pull-type distribution: In push-type distribution, communication is initiated autonomously in response to a server request. In pull-type distribution, it is initiated in response to a client request.

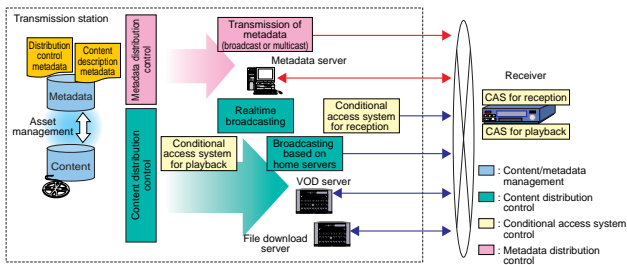


Fig. 1. Functions of distribution control technology that uses metadata.

## (2) Content distribution control

This function offers MPEG-2 TS content<sup>\*2</sup> over a broadband communication channel by means of the six types of services described above. All these services conform to the digital broadcasting service specifications for Hi-Vision service, data broadcasting service, and so on.

## (3) Metadata distribution control

The content metadata provided by the content provider is restructured according to the content distribution and distributed to users as content navigation information. The metadata is distributed by push- and pull-type servers, and the metadata registration, updating, and deletion at each server is managed by the metadata distribution control technology.

## (4) Conditional access

This function ensures that only subscribers can view content or use realtime broadcasting and broadcasting based on home servers. There is a choice of several cryptosystems for the encryption processing that protects against unauthorized use of content [1], [2]. Furthermore, detailed usage conditions can be specified by means of rights management and protection information (RMPI) written in XML (extensible markup language). The conditional access conforms to the specifications of ARIB (Association of Radio Industries and Businesses) in Japan [3].

These four functions can use distribution control metadata that describes the content management conditions and distribution conditions that have been

entered for the content to automatically manage content assets and control distribution according to the intentions of the content provider and the service requester.

This makes it possible both to guarantee the transparency of content distribution to the content provider by control based on the distribution control metadata set by the content provider and to reduce the increase in service operation cost, which is a problem when distributing content and metadata in multiple service forms.

## 3. Distribution control metadata

As distribution control metadata, NTT Cyber Solutions Laboratories has specified content management information and service control information in XML format, which has close affinity with the content metadata of the TV-Anytime Forum specifications.

- 1) Content management information: describes the input channel, input time, content format, information about the composition of the video, audio, and data content streams that constitute the content, duration, transfer rate, and content distribution permission conditions (time period, channel, and number of times).
- 2) Service control information: describes distribution time, distribution channel (service form), copy control information, request conditions concerning access control (encryption algorithm, key length, etc.), transfer rate, and so on.

The distribution control metadata from this information is managed with correspondence between the

<sup>\*2</sup> MPEG: motion picture experts group; MPEG-2: one of its standards for video format; TS: transport stream

content metadata and the content itself. It is used as control information by the four functions described above. The distribution control metadata and content metadata contain content reference identifiers (CRIDs) that conform to the TV-Anytime Forum SP004 specifications and serve to establish correspondence. The various methods of using metadata are shown in Fig. 2.

#### 4. System configuration

The configuration of a metadata use and distribution control system that was constructed on the basis of this technology is shown in Fig. 3. The modules that implement the the four functions are explained below.

##### 4.1 Content and metadata management

Digital content in MPEG-2 TS format and content

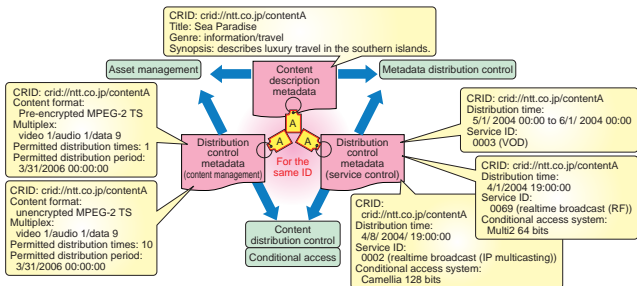


Fig. 2. Use of metadata.

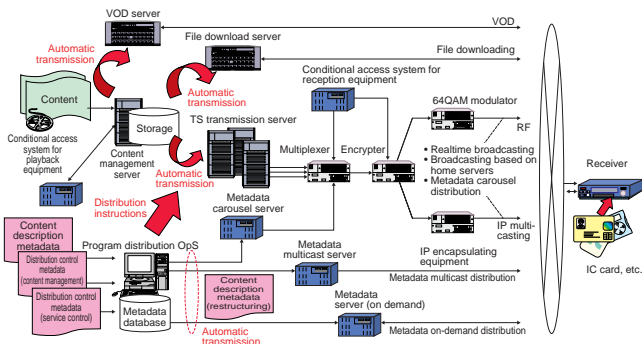


Fig. 3. Configuration of a distribution control system that uses metadata.

metadata are managed on the program distribution operations system (OpS). The locations of content and metadata within the system are maintained and the permitted distribution channel, permitted distribution time period, permitted number of distribution times, and other such conditions that are described in the distribution control metadata (content management information) are managed. Comparison with the managed permission conditions makes it possible to reject requests for distribution that violate the permitted conditions. Also, content for which the permitted distribution time period has expired can be deleted from the system, so use can be controlled according to the intentions of the content provider.

This function also differentiates between the instances of the same content in different formats by means of an internal asset management ID, allowing that content to be managed with the same CRID. For example, the same CRID can be assigned to both an MPEG-2 TS file encrypted for an external rights protection system for VOD services and an unencrypted MPEG-2 TS file that is to be encrypted just before realtime broadcasting, yet the two files can be managed separately. In this way, the differences in content format that arise from the different forms of service provision can be accommodated and presented to the user as the same content. Furthermore, as mentioned above, the graphical user interface (GUI) of the program distribution OpS provides search and display functions that make it easy to check on the circumstances of asset management and use.

## 4.2 Content distribution control

The content that corresponds to the CRID specified in the distribution control metadata (services control information) is automatically distributed by realtime broadcasting, broadcasting based on home servers, VOD or by file downloading (e.g., by http (hypertext transfer protocol)). In both broadcasting services, it is possible to select RF distribution, IP multicasting distribution, or both. Users who do not have access to the RF distribution infrastructure can receive broadcast content via the IP network.

When distribution control metadata (services control information) is input, the program distribution OpS extracts the CRID, distribution time period, service ID, and other such information. Within the system, correspondence is established between the service ID and the form of service. For example, if a service ID for realtime broadcasting is specified, instructions are sent to the MPEG-2 TS transmission equipment to control the broadcasting such that the

corresponding content is distributed on the specified channel for the specified time period. If a service ID for VOD or file downloading is specified, the corresponding content is transferred to the relevant server, registered, prepared for distribution according to the user's viewing request, and then deleted from the server when the specified time period has expired. In this way, various services can be provided easily by means of distribution control metadata (service control information) consisting of a CRID, distribution time period, and service ID in a simple, common format.

## 4.3 Metadata distribution control

Instance descriptions (such as published start time, published end time, channel information, and whether the content is charged or not charged, which are contained in the content metadata that is combined with the content and distributed to the user) must be consistent with the actual content distribution circumstances. Therefore, that information is extracted from the distribution control metadata (service control information) by the program distribution OpS, reflected in the instance description of the content metadata that is managed as an asset, and it automatically restructures the metadata for provision to the user. When this has been done, the description is changed in accordance with the service provision form. TV-Anytime Forum metadata specifications, which differ in description format, can also be handled automatically for broadcasting services and on-demand services. In this way, the metadata assets input to the system can be re-used any number of times independently of the form of service provision.

The restructured metadata is transferred from the program distribution OpS to various types of distribution equipment and servers, allowing both push-type distribution (carousal distribution over the RF channel<sup>\*3</sup> or multicasting over the IP channel) and pull-type distribution. The push distribution in this system involves distribution of the same information, so the load on servers is light, even for distribution to a large number of users, and updating of subject metadata on the transmitting side is also easy. Furthermore, pull distribution does not always occupy a fixed bandwidth, but allows flexible distribution of metadata according to the requests of individual users. In this system, metadata can be provided in single or multi-

<sup>\*3</sup> Carousal distribution: A method defined by ISO/IEC 13818-6 for repeated distribution of data for the purpose of downloading various kinds of data by broadcasting.

ple forms for each service form of content distribution. For example, it is possible to distribute metadata for relatively large-scale, member-only VOD services by IP multicasting, summary information by push distribution, and detailed information by pull distribution, with the special features of each reflected in the service.

#### 4.4 Conditional access system

This module implements a conditional access system (CAS) for the reception of realtime broadcasting services and a CAS for the playback of broadcasting services based on home servers. For the reception CAS, the encryption processing instructions described by the distribution control metadata (services control information) are sent from the program distribution OpS to the reception CAS equipment and issued synchronously with the distribution of content. This allows realtime encryption while distributing an MPEG-2 TS stream. The three cryptosystems that are available are the Multi2 system<sup>4</sup> currently specified for broadcasting in Japan (64-bit key length), the Camellia system<sup>5</sup> (128-bit key length), and the AES system<sup>6</sup> specified by the TV-Anytime Forum (128-bit key length). These cryptosystems can be used selectively as the content provider wishes.

For the playback CAS, on the other hand, detailed use and viewing control of content stored in the receiver, such as the number of playbacks and the valid time period, can be implemented in the CAS for playback processing equipment by converting RMPI, which is general-use permission condition data written in XML, to the equivalent account control information specified using ARIB standards.

### 5. Conclusion

We have explained distribution control technology for cooperative communication and broadcasting services that allows unified management of the operation of various kinds of services, including realtime broadcasting services, broadcasting services based on home servers, VOD services, and file downloading services through the use of metadata. We also described a distribution control system that employs

metadata and is implemented on the basis of the technology described here. In future work, we intend to study several methods of integrated distribution of content and metadata from the viewpoint of service priority and investigate the expansion of the practical application range, including the combination of cellular phones and wireless access.

### References

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<sup>4</sup> Multi2: A scrambling (encryption) method for digital broadcasting specified by ministerial ordinance.

<sup>5</sup> Camellia: A common key block encryption system developed jointly by NTT and Mitsubishi Electric.

<sup>6</sup> AES: The next-generation standard cryptosystem currently being considered for selection by the National Institute of Standards and Technology of the U.S. Department of Commerce.