IP Storage and Stored Content Management Using SIP Presence Server with XML Database

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***Abstract*—There are few studies of content delivery systems specializing in consumer generated video (CGV) exchange, and as for the real exchange technique, exchange through the file server in a network has become mainstream. A solution using P2P has been also proposed, but a structure for safe content exchange guaranteed by the service provider is necessary for the further spread of a service. Therefore, we propose a distributed storage video on demand system (DSVS) for delivering CGV content stored in a user IP storage. It is important to know how the server in a network manages stored CGV(s), including the storage. A standard system for managing the storage and also the stored files does not exist. Thus, we propose a storage management system, a part of our DSVS, that uses a session initiation protocol presence function and an XML database management system. These are additional functions of the IP multimedia subsystem, which is a core system of the next generation network (NGN). In Japan, access services for the IPv6 Internet and an NGN with one IPv6 address began in 2011. Therefore, the number of potential NGN users will increase with the spread of the IPv6 Internet access service. We show that our system can become the foundation of various content delivery services due to the versatility of the storage management capability of our DSVS.**

***Index Terms*—IP storage, iSCSI, IMS, SIP, XDMS, VoD**

I. INTRODUCTION

The Internet has many service sites for sharing video content including consumer generated video (CGV). A service provider (SP) of such a site gathers content to share, and managing such content in one place is simple and easy. However, there are two issues with this management method.

The first issue is storage cost for an SP. A CGV with few views occupies the same storage capacity as a CGV with many views if the file size is the same. Storage cost then becomes something an SP cannot ignore when there is a huge number of CGV(s).

The second issue relates to copyright management. Videos recorded from TV broadcasts or from DVDs are often uploaded by individuals to sites. It is difficult to identify who has breached copyright after a video is uploaded, and it is even more difficult to automatically detect videos in violation of copyright. Currently, we manually check whether an uploaded video is legal or illegal, which requires additional human labor. A P2P system, which implements cryptography to secure the anonymity of a content holder, has a similar issue.

Our approach for these issues is to manage the meta-information, including access parameters for storage and CGV(s), and to construct a system enabling access to a CGV by on-demand connection. We call this a distributed storage video on demand (VoD) system (DSVS). The SP is then free from storage costs, and it is clear who opens a CGV. In Japan, access services for the IPv6 Internet and an NGN [1] with one IPv6 address began in 2011. Especially important is the possibility that the number of potential NGN users increases with the spread of the IPv6 Internet access service. An NGN is available to users of the IPv6 Internet access service only by an additional application.

There are two core techniques for the DSVS. The first is IP storage access throughput control in a long-delay network. We treat IP storage and the Internet Small Computer Systems Interface (iSCSI) [2] storage as having the same meaning. The iSCSI protocol is available for the IPv6 as well as the IPv4. The throughput simulation results of our control system are shown in [3]. The second is for storage management. In [4], Zhu *et al.* describe the end-user lookup service for the dynamic discovery of the IMS and non-IMS clients. Most of the studies to treat a device management system with the session initiation protocol (SIP [5]) device management mechanism and a SIP presence server (PS) of an IP multimedia subsystem (IMS) are performed in mobile (3G/WiFi) devices. Therefore, it is complicated and economical efficiency is not good because these architectures are for general purpose. In our previous study [6], we examined the architecture of managing objects using only an XML database management system (XDMS) [7], which is superior in flexibility for defining an element using XML. However, the processing capacity may not be sufficient to assume that an XDMS of an NGN manages static objects as the main purpose. The SIP PS has low extensibility of elements but scalability is high, and there are many softwares superior in utility. Therefore, we re-designed it to increase the utility of the entire system by removing the heavy load caused by presence management from the XDMS.

In this paper, we call IP storage simply ”storage”. Our storage-management system includes the status (presence) of storage, access-parameter management, and meta-information management of the stored CGV.

The storage-management system is not only an application for our DSVS. We show that this system can be a platform for content SP(s).

The organization of this paper is as follows. First, we describe our DSVS as a content delivery system specialized in CGV exchange in Section II. Next, we describe our proposed storage management system in reference to the Internet storage name service (iSNS) [8], which is the storage management standard of the Internet standard, in Section III. Then, we explain the system configuration of our DSVS using the application program interface (API) the storage management system provides, and the presence management technique of storage in Section IV. Finally, we conclude this paper and present future work in Section V.

II. DISTRIBUTED STORAGE VoD SYSTEM (DSVS)

Figure 1 shows an overview of our DSVS. The basic function of the DSVS is as follows. A VoD client user confirms the presence of storage by displaying it on a web page. If the user chooses a CGV title that is shown as available, the storage in which the selected CGV is stored is accessed by the VoD server through the iSCSI protocol. Then the storage sets the presence as unavailable, and the CGV is streamed to the VoD client by the VoD server. This presence condition is the same as that of a telephone exchange, and the system limits the number of users that can access the storage at the same time. The relations of the VoD server and the storage constitute a one-to-one pair. Because the VoD server has a file system, the concurrent connection is not made to the storage from several VoD servers. By this system, it is necessary for a storage to control the availability depending on the number of accesses to a specific storage.

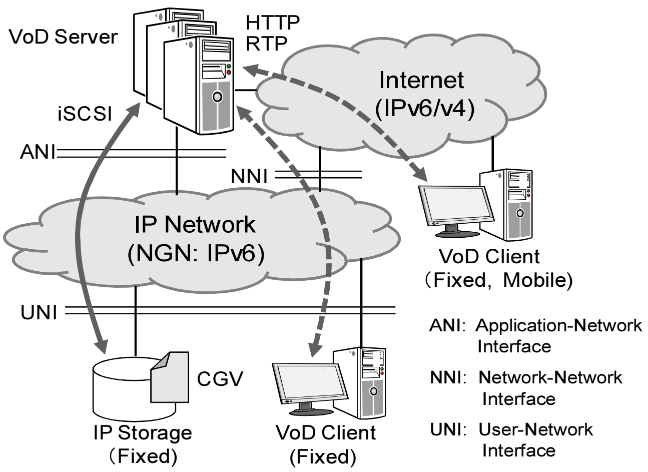

Fig. 1. Overview of distributed storage VoD system (DSVS)

We assume the IPv6/v4 Internet and mobile 3G/WiFi linked IP network as target over which streaming transfers occur. A person who wants to show his/her CGV(s) does not upload them but stores them in his/her storage. For on-demand access using the meta-information of storage and CGV(s), the VoD server acquires this information. For on demand access, access from the VoD server to many local user environments is necessary, and bandwidth above a certain level from these environments to the VoD server is also necessary. Therefore, we focused on a managed IP network as an NGN, not the Internet, as the network between the VoD server and the local environment. Such a network is suitable as a component for the DSVS because an NGN includes a carrier-grade quality of service (QoS) management function on the edge router classfying data to transfer into three media classes (i.e., voice, video and data stream) (Fig. 2), and a security function based on the identification information of the sender, similar to a home telephone, as a standard. Therefore, unlike the Internet, an NGN can monitor access from the outside as a network function. Many trials for accessing devices, such

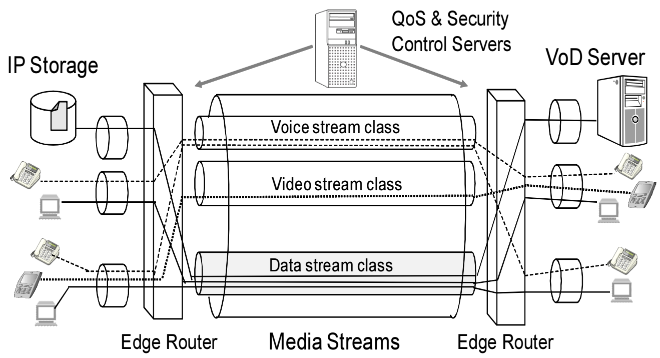

Fig. 2. NGN as managed IP network

as surveillance cameras or storages in a home, assuming the Internet as the network, have been and are being performed. The issue of such trials is access control into a home network. Thus, an NGN avoids the two issues mentioned above. We chose iSCSI storage because an iSCSI protocol [2] requires lightweight processing and operation is simple for other types of home storage. The VoD server can make remote connections via an IP network (Fig. 3).

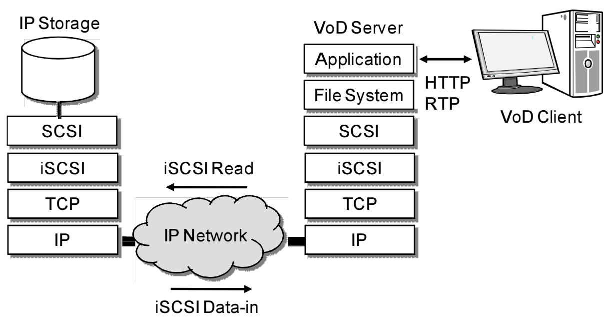

Fig. 3. iSCSI access from VoD server to IP storage

III. STORAGE MANAGEMENT

This section first describes the storage management technique of the Internet standard and then describes our proposed system.

A. Internet Storage Name Service (iSNS)

The Internet storage name service (iSNS) and iSCSI are IP-based storage networking standards for linking data storage facilities. The iSNS system is also available for the IPv6/v4 protocol. The iSNS provides IP-based storage management services similar to those found in fibre channel (FC) networks, enabling a standard IP network to operate in the same way as an FC storage area network (FC-SAN). The iSNS protocol (iSNSP) is used for interaction between iSNS servers and iSNS clients and facilitates automated discovery, management, and configuration of iSCSI and FC devices using the Internet FC protocol (iFCP) [8] gateways on a TCP/IP network. The iSNSP is a flexible and lightweight protocol that specifies how iSNS clients and servers communicate. Figure 4 shows the iSNS framework.

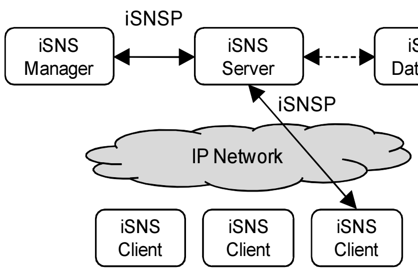

Fig. 4. iSNS framework

The iSNS servers respond to iSNSP queries and requests, and initiate iSNSP state change notification (SCN). Properly authenticated information submitted through a registration request is stored in an iSNS database, which is the information repository for the iSNS server. It maintains information about iSNS client attributes. The iSNS server has five main functions.

1) Name service providing storage resource discovery
2) State change notification (SCN) service
3) Entity status inquiry (ESI)
4) Discovery domain (DD) and login control service
5) Open mapping of FC and iSCSI devices

iSNS clients initiate transactions with iSNS servers using the iSNSP. iSNS clients are processes that co-reside in the storage device and that can register device attribute information, download information about other registered clients in a common DD, and receive asynchronous notification of events that occur in their DD(s). Management stations are a special type of iSNS client that have access to all DD(s) stored in the iSNS. There are five main types of iSNS clients, iSCSI initiator, iSCSI target, iSCSI-FC gateway, iFCP gateway and management station.

Figure 5 shows an example of a standard iSNSP sequence. This sequence relates to the VoD server and the storage, when the iSNS server sends an SCN. The procedure is as follows. First, registration (iSNSP DevAttrReg) to the iSNS server of the storage is carried out. Next, there is a notification (iSNSP SCN) of the storage to the VoD server. Finally, an access information inquiry (iSNSP DevAttrQry) from the VoD server is made. These parameters included in each iSNS data unit are the most important.

The iSNSP is a message-based protocol, and most operations use a single transaction form. The iSNSP replies with the corresponding response message, such as the SIP. The iSNS can manage the availability of storage devices, but never the meta-information of stored CGV(s).

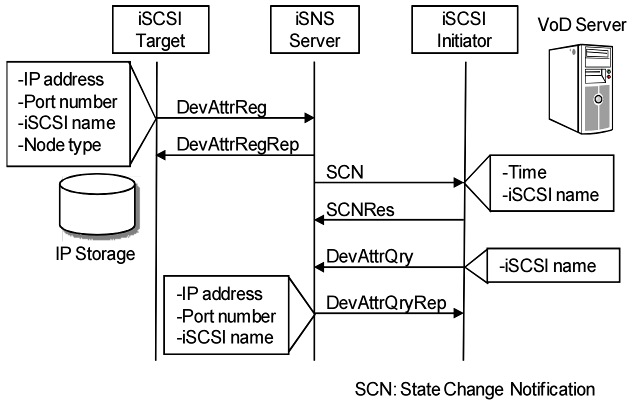

Fig. 5. Example sequence of standard iSNSP session

B. Storage management using SIP presence with XDMS

A SIP presence administrative function is attached to the IMS as the core system of an NGN. There are two reasons for not adopting iSNS in an NGN. An NGN is a SIP-based network, and implementation of SIP becomes indispensable to the iSNS device. Therefore, the first reason is that the implementation of a similar function is unnecessary. The other reason is that the availability of the iSNSP without a limit in an NGN network is unknown. This reason depends on the specifications of the carrier's network.

Figure 6 shows the standard configuration of an IMS system.

The basic core of the IMS is constructed mainly on an SIP server and is called the IMS core. In existing networks, other IP and radio (3G) networks are contained in the IMS core in the future. In addition, SIP appilication servers are connected as additional equipment to enable multimedia service.

The IMS is defined by 3GPP/3GPP2 (www.3gpp.org) [9] as a generic architecture for offering reliable and scalable multimedia services over Internet protocol (IP) networks. Therefore, the storage connecting with an NGN is contained in the IMS core like a radio network device. The storage device management technique using the iSNS has many technical similarities with a SIP PS, which is a SIP applications server. The main management object of a SIP PS is almost equal to that of an iSNS server, and it is not appropriate to add management objects to the information of stored CGV(s). A technique for determining the owner of a remote iSNS device is necessary when a wide area network (WAN) is applied because the reliability of the identification given to iSNS devices is inherently not in the specification.

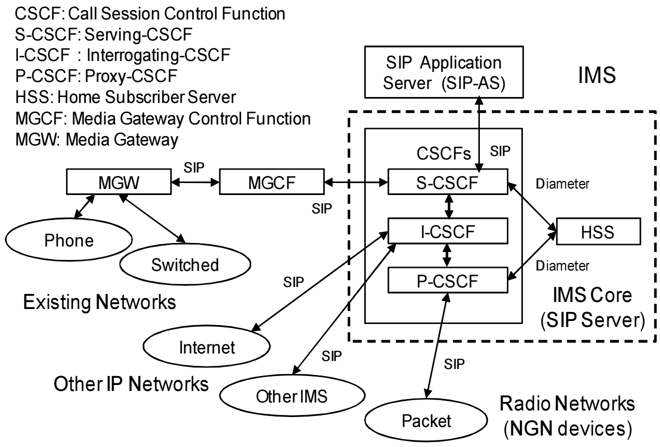

Fig. 6. Configuration of standard IMS system

The purpose of our management system is to economically establish the uniqueness and reliability of storage devices by adding a carrier-grade SIP device management mechanism. To manage CGV meta-information in a storage, we used an XDMS, which is an additional function of the IMS. Each storage accesses the XDMS using the XML configuration access protocol (XCAP) [10]. XDMS is not a part of the IMS network, and it is classified as a service delivery platform (SDP: Fig. 7). Managed information using a SIP PS and meta-information using the XDMS are linked through a SIP uniform resource identifier (URI). Table I lists items that a SIP PS and XDMS constituting the storage-management system should manage. The SIP PS manages the first five items, including SIP URI, and the XDMS manages the items after SIP URI, including the future expansion items.

Our management system achieves the basic administrative functions by using the SIP PS and the XDMS, but the full

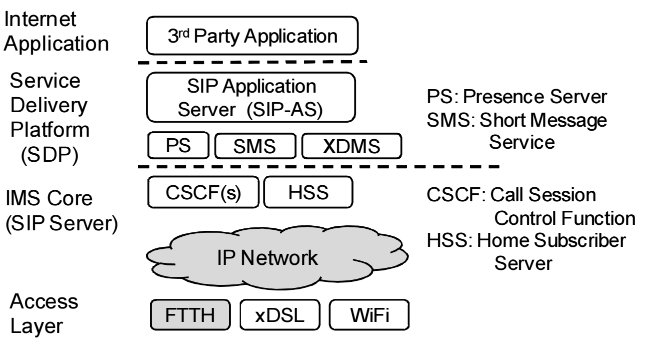

Fig. 7. XDMS and SDP layer

TABLE I
MANAGED STORAGE INFORMATION

Item	Comment
Presence	Power ON/OFF or accessibility by iSCSI
IP address	Storage's global IP address
Port number	Storage's TCP/UDP port number
Target name	Specific name in iSCSI
SIP URI	SIP device identifier
File system	Mounting parameter for the VoD server
ID information	Authentication parameter for iSCSI session
Meta-information	Title or file name of CGV

specifications of iSNS are not supported. For example, our management system supports equivalency of functions 1) and 2) from the five functions of the iSNS server introduced in Subsection A. Our system can also manage function 3) by using a process of SIP device management. It is necessary for this function to be equivalent to function 4) to achieve the upper layer administrative function of the VoD server.

IV. SYSTEM CONFIGURATION

A. Storage Management API

Figure 8 shows the configuration of our DSVS system. We use SailFin [11] as the API for the VoD server. SailFin, indicated by SIP-AS in Fig. 8, is based on a robust and scalable Java servlet container for SIP [5] built on GlassFish, which is the first compatible implementation of the Java EE 6 platform specification. A software developer can easily construct a system that uses SIP processing by using SailFin. The VoD server handles SIP signals by using the simple object access protocol (SOAP) [12]. The SOAP interface is our original implementation. Figures 9 and 10 show example sequences.

When the SIP-AS receives a SOAP-based SUBSCRIBE including the SIP URI of the storage through the API from the VoD server, the SIP-AS transmits the SIP SUBSCRIBE [13] to the SIP PS and the XDMS. When an update of the information

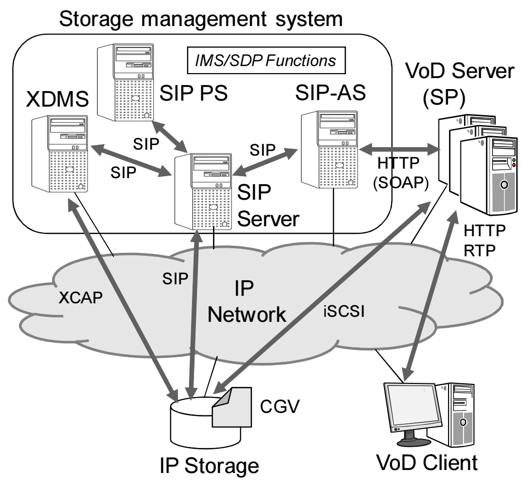

Fig. 8. Configuration of DSVS and storage management system

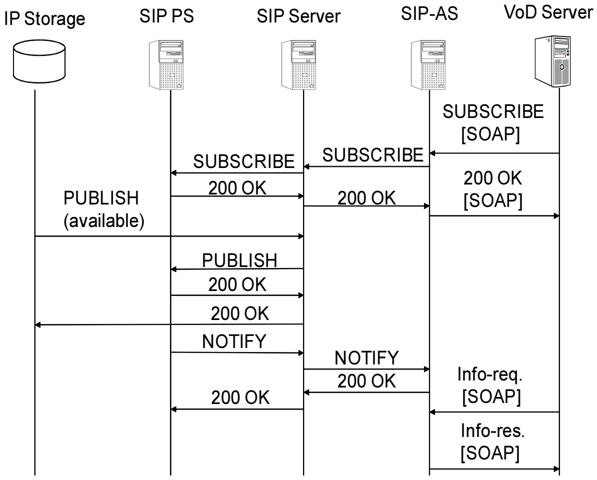

Fig. 9. Example sequence for availablity notification

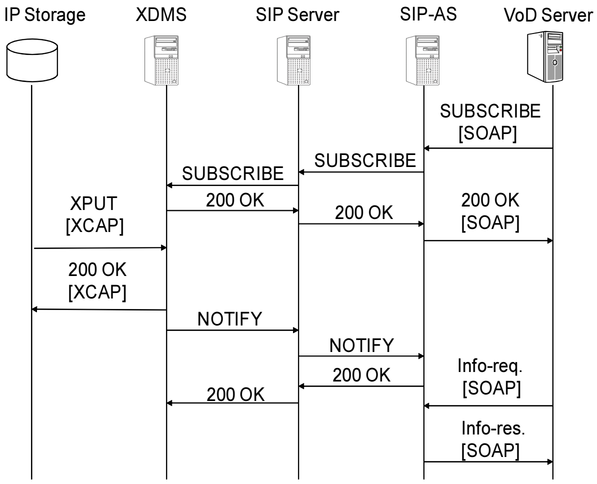

Fig. 10. Example sequence for meta-infomation notification

is carried out from a storage, both the SIP PS and XDMS issue SIP NOTIFY to the SIP-AS. The VoD server accesses the SIP-AS regularly, indicated by ”info-req” in Figs. 9 and 10, and confirms whether there was SIP NOTIFY from the SIP PS and the XDMS. The VoD server determines from the result whether the related storage information was updated. When the update is confirmed, the VoD server updates a web page using the updated XML information (i.e., file name or video title). Because the SIP-AS provides storage information as an API, SP(s) can access the API and handle the latest storage information and content.

B. Presence management

In our previous study [6], we examined the architecture to manage both the presence and meta-information of a storage. We re-designed the system to use both a SIP PS and an XDMS, and manage presence with the SIP PS. Therefore, a storage registers its own presence with the SIP PS by SIP PUBLISH [14] (Fig. 9). Listing 1 shows an example of a SIP PUBLISH notation.

Listing 1. Example of SIP PUBLISH notation by storage

```
<?xml version=”1.0” encoding=”utf−8”?>
<presence xmlns=”urn:ietf:params:xml:ns:pidf”
          xmlns:dm=”urn:ietf:params:xml:ns:pidf:data−model”
          xmlns:rpidf=”urn:ietf:params:xml:ns:pidf:rpid”
          xmlns:c=”urn:ietf:params:xml:ns:pidf:cipid”>
  <tuple id=”com1”>
    <status>
      <basic>open</basic>
    </status>
    <note>communication_note</note>
      <timestamp>2010−11−09T10:09:00Z</timestamp>
  </tuple>
  <dm:person id=”per123”>
    <rpidf:activities id=”act1”>
      <rpidf:travel/>
        <rpidf:note>available</rpidf:note>
      </rpidf:activities>
    <rpidf:mood id=”md1”>
      <rpidf:note>mood_none</rpidf:note>
      <rpidf:happy/>
    </rpidf:mood>
  </dm:person>
</presence>
```

The storage sets its own presence as available with a time stamp, and transmits SIP PUBLISH. The reason for adding a time stamp is to detect whether the presence is updated or not if the storage is turned off. The SIP presence management does not monitor polling.

The meta-information of the storage is managed by the XDMS. The storage registers the meta-information by XCAP, and updates or deletes it. Listing 2 shows an example of an XPUT notation.

Listing 2. Example of XPUT notation by storage

```
<?xml version=”1.0” encoding=”UTF−8” standalone=”no”?>
<target ip=”2001:DB8::8:800:200C:417A”
        port=”3260”
        targetname=”iqn.2009−10.com.example:target.1”
        sipuri=”mmc−vod1@ims−lab.ntt.co.jp”
        filesystem=”ext3”
        uuid=”df80c09b−00eb−477e−b544−f9f1b8632637”>
   <videoList>
       <video permission =”Prov−A,Prov−B”>
         <title>Sea Party</title>
         <path>/dir/Dolphins_720.mp4</path>
       </video>
       <video permission =”Prov−A”> >
         <title>Sakura in Japan</title>
         <path>/dir/Dust_to_Glory_720.mp4</path>
       </video>
   </videoList>
</target>
```

XPUT is a command set in the XCAP data format. The meta-information of CGV(s) and necessary information for the VOD server to access the storage is shown. In addition, the storage management system can set access control in the content for

SP(s) by describing the SP offering the storage information in the permission attribute of the video element. In Listing 2, the meta-information of the CGV titled ”Sakura in Japan”, can be accessed only by using service provider ID of Prov-A. The SIP PS and the XDMS publish SIP NOTIFY corresponds to the SIP-AS when registered information is updated. The SIP-AS maintains both notifications for SP(s).

C. GUI example

The VoD server has a web server function that accepts a VoD request from the VoD client. The VoD server then accesses the storage using the iSCSI protocol and streams in the real-time transport protocol (RTP). The VoD client accesses a CGV to play from among a list of CGV(s) displayed on the web page. Figure 11 shows an example of a web user interface (UI) with a video screen. On the left side under the screen, the CGV names are displayed as meta-information. The state of the storage where CGV(s) are stored is displayed to the right as presence. The status of the storage is updated based on the availability information, which the VoD server periodically acquires.

In the list of CGV(s), a storage where the contents of the first three CGV(s) are stored becomes available, and a storage where the succeeding three CGV(s) are stored becomes unavailable. The relations of a VoD client and the storage assume a one-to-one connection like that of a telephone call as a general configuration. Thus, when the storage is already connected to the other VoD server, the status of the storage should be displayed as unavailable. However, access to the same storage when there are different clients accessing the same VoD server is possible.

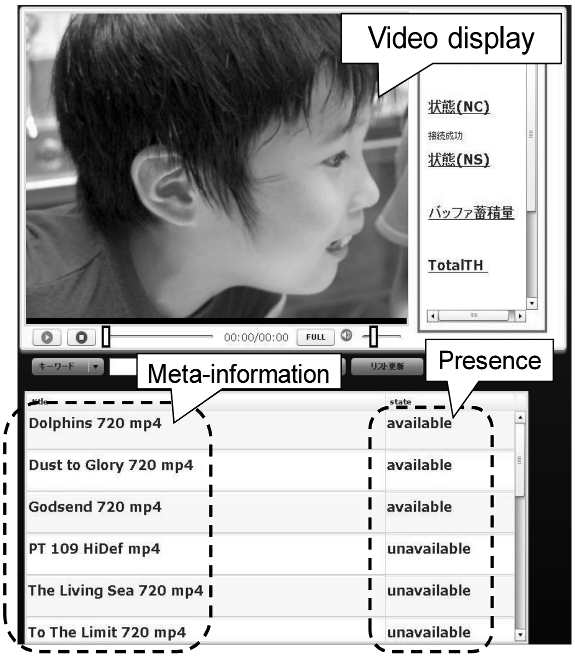

Fig. 11. Web UI example on VoD server

In a situation where multiple access to the same storage is repeated, we should implement the caching function on the VoD server.

V. CONCLUSION

We described the implementation of our DSVS which streams CGV content stored in a user storage, and the storage management system we constructed using IMS/SDP functions. The storage management system, which updates and acquires information such as the video content stored in the storage and the presence of the storage, was constructed using a SIP PS, an XDMS, and the SIP-AS that has the original API. Because SP(s) can use the storage management system through the API of the SIP-AS, other applications apart from the VoD system suggested in this paper are possible, broadcast CGV delivery by an IP multicast or encoding conversion service. The proposed system uses the SIP server and the SIP PS of the carrier-grade comprising the scalability, so rapid implementation is feasible, but the scalability of the XDMS should be evaluated. For future work, we will examine the cach data management on the VoD server, when the number of accesses to specific CGV(s) increases.

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