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The Design and Implementation of a Broadcasting Management Web System for IPTV

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Abstract

Convergence is one of the most popular buzzwords in the academic, research, and industrial fields. One of the most successful examples of convergence is Internet Protocol Television (IPTV), a convergence of communication and broadcast methodologies. In this study we introduce the 'Open IPTV System' that allows subscribers to easily open their own IPTV broadcasting station. We then investigated the broadcast management system (BMS) of the 'Open IPTV System'. Finally, we designed and implemented a broadcast management web system that allows the operators to access the BMS anytime and anywhere as long as they are connected to Internet.

Keywords: *IPTV, broadcast management, web system*

1. Introduction

Convergences, such as system convergence, technological convergence, bio-convergence, and IT-convergence are some of the most popular buzzwords in the academic, research, and industrial fields. One of the most successful examples of convergence is the Internet Protocol Television (IPTV) system, which is a convergence of communication and broadcast methods. IPTV is defined by the ITU-T FG IPTV as: "IPTV is defined as multimedia services such as television/video/audio/text/graphics/data delivered over IP based networks managed to provide the required level of quality of service and experience, security, interactivity and reliability" [1]. Based on this definition, we can conclude that the smart TV is also a kind of IPTV. If someone coins a new term such as 'intelligent TV' or 'active TV' to indicate an innovatively improved version of smart TV it will also be a kind of IPTV as long as it is a multimedia service delivered over IP based networks.

An IPTV system usually provides live television, time-shifted programming, and video on demand (VOD) [2-5]. The live television service captures the inbound TV broadcast signals in real time and encodes the TV channels. The time-shifted programming service allows operators to retrieve digital content, to make playback schedules, and to assign the schedule onto a channel. The VOD service allows users to select and watch a video. These IPTV services are so attractive that IPTV is starting to dominate the TV market.

An IPTV system consists of many component systems, including linear encoders, linear broadcasts, content management servers, data servers, nonlinear encoders, nonlinear broadcasts, and client portal servers. This implies that delivering an IPTV system demands a huge budget. The 'Open IPTV System' shown in Figure 1 is an IPTV system that allows individual or collective subscribers to easily open their own IPTV stations using its infrastructure.

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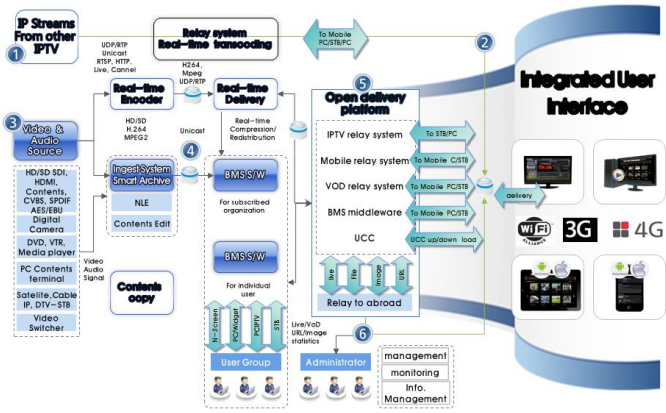

Figure 1. The 'Open IPTV System'

In Figure 1, ① represents the IP stream from other IPTV systems. The 'Open IPTV system' captures the IP streams from other IPTV systems, transcodes them into the H.264 format if needed, and then transmits them to a router that is the connection point to the outside world. ② represents the line from the encoder to the router. ③ represents the multimedia contents(video and audio source) such as HD/SD SDI, HDMI, CVBS, SPDIF AES/EBU digital cameras, DVD, VTR, media players, the PC terminal, satellite, cable IP, DTV-STB, and video switchers. A video or audio source is either encoded into H.264 in real-time by a real-time encoder or edited by the operators using non-linear editors for delivery. ④ represents that the outputs of step ③ are transmitted to the broadcast management system (BMS). The end users can access the BMS and enjoy the IPTV services. ⑤ represents the N-screen open transmission platform (mobile, PC, STB). ⑥ represents that the administrators monitor and manage the IPTV system by accessing the open transmission platform and the router.

The BMS determines whether or not the users have permission to watch the designated content, to open their own IPTV station, and to manage the contents. If the permission check is positive, then the BMS allows the user to enjoy the content, and updates the bill for the user. If the user has permission to open his own IPTV station, then the BMS allows the user to register new content, retrieve and update his content information, and delete existing content. Similarly, if the user has permission to manage the content, then the BMS allows the user to register, update and delete the IPTV content. Considering the above mentioned roles of the BMS, we can conclude that the BMS is very important and must run continuously. As shown in Figure 1, the administrators have to be present in the control room in order to run the BMS. This study has developed a broadcast management web system so that the administrators can monitor and manage the 'Open IPTV System' anywhere and anytime, as long as they are connected to the Internet.

2. Related Works

This paper develops a web BMS for the 'Open IPTV System'. Therefore, the IPTV system, broadcast management, and web system are included in the related topics. Among the IPTV services, namely live television, time-shifted programming, and video on demand (VOD), VOD is the most popular. The authors of [6] proposed the 'collaborative delivery of content' strategy. The basic concept of the strategy is to have many regional mirror stations regarding the IPTV contents instead of only keeping the

content at the central station. When a user's request arrives at the regional station, this station may ask other stations for help if it is too busy.

The authors of [7] proposed a new strategy regarding home network management for IPTV service. Their main concern was in guaranteeing quality of service. For this purpose, their strategy gathers a variety of IPTV-related data from the set-top boxes and then to provide some useful management functions (*e.g.*, video/audio packet loss analysis and IPTV audience rating) to ease service assurance and the exploration of subscribers' tastes for IPTV programs.

The authors of [8] proposed a new definition for the real-time transport protocol (RTP) system target decoder (STD) that can be used to converge the broadcast and the Internet world in IPTV. The advantage of the new definition is that the difference between MPEG2-TS and the new definition is minimal. That is, the broadcast signals can be converted into IPTV signals with a minimum of effort.

Before the multimedia broadcast service (MBS) can transmit its service flow in a mobile WiMAX system, the connection ID is required. Therefore, mobile IPTV users always need to perform two processes before they are able to view a program channel: perform the IGMP join/leave at network layer and obtain the connection ID at the MAC layer. The authors of [9] proposed a new extended IGMP protocol which can be used in the mobile WiMAX radio access network in order to let the mobile IPTV services reduce their channel change time on the network.

Cost-efficiency, operation flexibility and high bandwidth are attractive features that the next generation network has to provide to service providers. In order to achieve these characteristics, the network needs to have Quality of Service (QoS) provisioning abilities. As a means of providing QoS, the authors of [10] introduced a topology-based hierarchical scheduler scheme, which controls the incoming traffic at the edge of the network based on the network topology.

It is known that popularity-based interval caching is effective in the improvement of the performance of video streaming services in the IPTV environments. In order to further improve the performance of the caching scheme, the authors of [11] proposed a block level buffer management scheme and showed, using simulation results, that the proposed scheme improved the cache hit rate.

A subscriber at home catches IPTV signal with a set-top box that decodes MPEG-2 video and displays video on TV screen. The authors of [12] introduced a digital channel generation apparatus with which a channel service producer can easily set up a digital channel without programming.

We can develop a new web application system much more efficiently by reusing existing programs running on various platforms all over the world. Web service [13-16] is one of the techniques used to reuse programs developed by other organizations on their proprietary platforms. In web service, a published program is described in WSDL (Web Services Description Language) [17-18] and registered on UDDI (Universal Description, Discovery and Integration) [19]. Web application developers access a UDDI and search for a program that provides the function they desire. They can use a published web service by inserting a few instructions to invoke it in their applications. The application communicates with the service provider using SOAP (Simple Object Access Protocol) [20].

3. The Functional User Requirements for the BMS

The functions of BMS are enumerated in Figure 2 and are categorized into two groups: 'basic functions' and 'Broadcast Functions'. The basic functions include 'Contents Registration', 'Contents/Metadata Update', 'Service Statistics', and 'Registration/Update of Related Contents.' Broadcast functions include Category, Group, URL/IMG/Live/VoD, Subscribers, Content Price, Notices, News, Administrator Registration/Update, Administration Log, and Management of News/Notice.

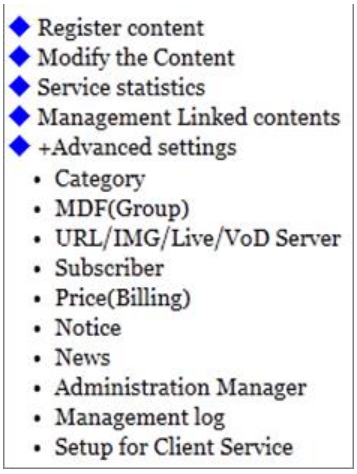

Figure 1 The menu items

'Contents Registration' provides functions to display content information, searching information with content description, creating and registering new content, updating content information, and deleting content. We can register a content file as it is originally or after encoding it into the h.264 protocol. When a content file is registered, the group and the server to which it belongs can be designate and a metadata aspect can also filled out after uploading the content file. The content information includes content ID, content name, description, and the manager of the content. Updating content information changes the existing content information. Deleting content deletes a content file and the metadata associated with it.

The 'Content/Metadata Update' function allows administrators to register, update, and delete metadata. The metadata includes content title, genre, length, copyright, the thumbnail, producer, and actors. It opens a content search window when it is clicked. In this window, we can select the metadata particulars and update or delete them. Deleting metadata does not delete the associated content file.

Service Statistics provide statistical information in regards to the following.

- Contents: For each broadcast type, each content category (Live, VoD, Image, and URL), and each of the operators, this menu provides the number of content items belonging to it.
- Stream server: For each of the weekdays and for each of the stream servers, this menu provides the number of visits and the number of videos being watched.
- Subscribers: For each of the age types and gender types, this menu provides the number of visits and the number of watched videos.
- Content provider: For each of the content providers, this menu provides the number of active (or inactive) content items provided by the content provider.

- Group: For each of the groups, this menu provides the number of content items and number of subscribers.

The "Registration/Update of Related Content" menu allows the administrators to register and update the related content items. After watching a video, a subscriber can conveniently continue watching videos related to the original.

The Category menu provides functions to design a menu (user interface) regarding the main home page of the IPTV station opened by a subscribed user of a subscribed group. For example, if a city (for example Chicago) wants to open its own IPTV station, it can open a 'Chicago IPTV station' under the 'Open IPTV System'. The 'Category' menu allows the Chicago implimentors to easily construct their home pages. The structure of the main home page of the implemented station (the Chicago IPTV station) of the subscribed group is two-layered: the main menu and the submenu. Using the Category function, the subscribed organization (Chicago) can specify the main menu items and submenu items. For the submenu, they (Chicago, for example) can register posters that appear on the end-user's interface.

The group menu allows the operators to register, update and delete a group. For each of the groups we can designate a stream server, register a poster to be used as the background image, and register the RSSs(really simple syndication).

The URL/IMG/Live/VoD menu allows the operators to register, update, and delete a server to each of the URL/IMG/Live/VoDs. Using this menu, we can also designate a server for each of the groups. If a VoD/Image streaming server is assigned to a group, a content item is uploaded into this server when the content item is registered.

The subscriber menu provides the functions of registration, updates and the deletion of subscribers. When it registers a new subscriber, it records the ID, password, birth date, and gender. This recorded information is utilized by the statistical, login system and billing system. Referring to this information, the login system allows or disallows the access to the IPTV system and establishes the length of time allowed to the user to access the system. This menu also takes care of the prepayment system.

The content price menu allows the operators to register, update, and delete the content price table. For each of the content items the price can be specified and the length of the time period during which watching is free.

The notice menu allows the operators to register, update, and delete a notice. A notice can be public to all subscribers or to a specific group of subscribers. This menu can selectively display notices based on the title or the content. This menu also displays the posters.

The news menu allows the operators to register, update, and delete news. Similarly to the notice menu, a news item can be public to all subscribers or to a specific group of subscribers. Unlike a notice, the news is delivered to the users in a real-time manner. This menu also displays posters together with titles and content.

The administrator registration/update menu allows the operators to register, update, and delete administrators with permissions (content registration, category registration, management of subscribers, and so on) allowed to the administrator.

'The log of administration' menu records all of the jobs performed by the administrators of the system. Referring to this record, a manager can determine who is overloaded and whose content is registered on a given date.

The management of news/notice menu provides the following function: for each of the news/notice items it can be specified whether or not this item should be published to the subscribers. When a new news/notice is created the reload time can be specified. The reload time is the moment when the news/notice item is published. We can also determine the

subscribers to whom this news/notice is open. Using this menu, we can quickly inform the subscribers of newly available content.

4. The Design

As was mentioned in Section I, the 'Open IPTV System' described in Fig. 1 inferred that the BMS was already installed and running. The purpose of this paper is to design and implement a web BMS so that the operators can manage the broadcast through the Internet. Therefore, we are planning to implement a client through HTML and JavaScript and implement a server using PHP programming language. Among the user requirements the Content Registration, Management of Subscribers, and Statistics fields require a database to store, retrieve, update, and delete the pertinent information. Therefore we need a web server and a database server at the server site.

Amongst the many available database management systems, we have chosen My-SQL for our implementation. Recalling the user requirements, we find that we need 64 tables in our database: content, copyright, category, subscriber, stream server, set top box, and so on. Each of these tables is associated to many attributes. For example, a content item is associated with the name, consignee, consignor, date of obtaining, place of obtaining, and so on. In addition to the tables, our database provides many useful functions that can be used to manipulate the data (crate, read, update, delete) in the tables. We define these functions in the DataLayer class. In addition to those functions, other functions of the connection to the database regarding the executive query and the of closing databases are also defined in the DataLayer.

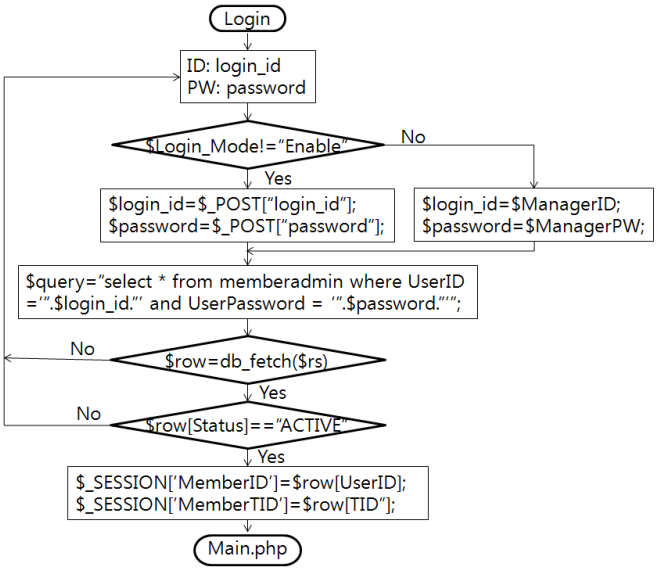

Figure 3. The process of looking up the ID and password in the database

Whenever a user accesses the 'Open IPTV System', the very first function to be executed is the Login function. The Login function checks whether or not the user is an authorized subscriber by looking at the input ID and pass word in the database, as shown in Figure 3. It then checks the permissions allowed to the user by referring to the database. With the permitted menu items, it configures a user interface for the user, as shown in Figure 4. For example, if the 'Content Registration' function is not allowed to the current user, it disables

this menu item on that user's interface. Database access and login functions are common processes required by almost every web system.

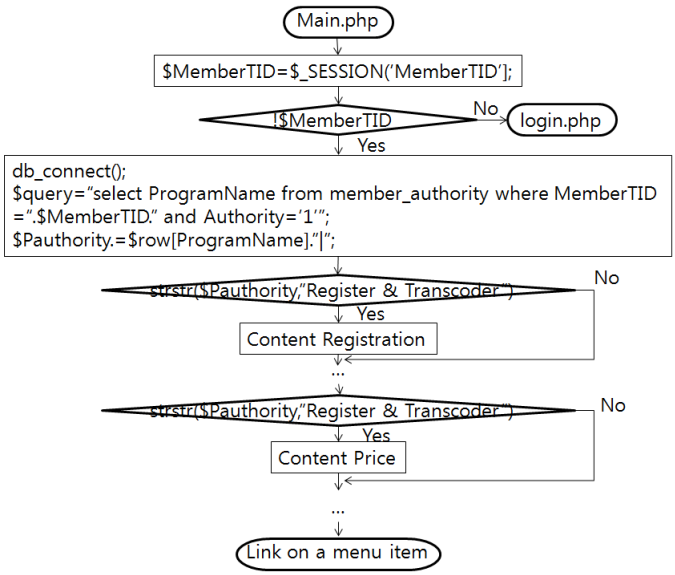

Figure 2. The configuration of menu items process

We will skip the discussion referring to the design of several of the menu items and move to the Category designation. As we discussed in the "User Requirement" section, the main purpose of the Category domain is to build a user interface for an individual user or a subscribed organization (Chicago, for example) that opens his (its) own IPTV station. The user interface is two layered. 'Category' displays a list of all the categories and allows the user select both main and sub categories. The database is updated accordingly. The user interface regarding the 'Category' consists of two frames: one for main the category selection and the other for the subcategory selection. The user is allowed to change the positions of these frames. The 'Category' process is shown in Figure 5.

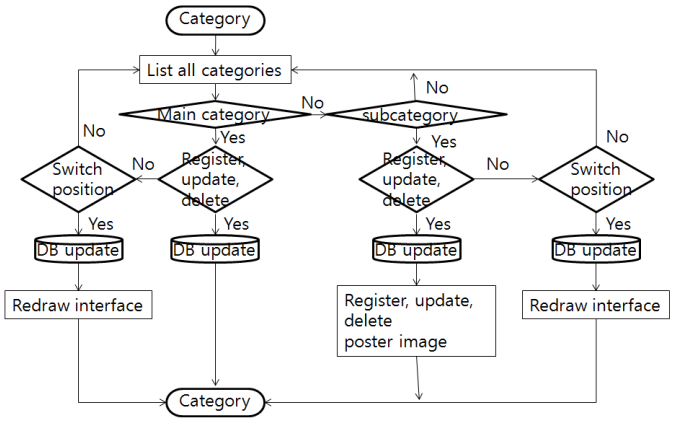

Figure 5. The 'Category' process

The 'Group' menu allows users to register, update, and delete group information. For each of the groups, we can designate a poster as its background image and register the RSSs. The Group process is shown in Figure 6.

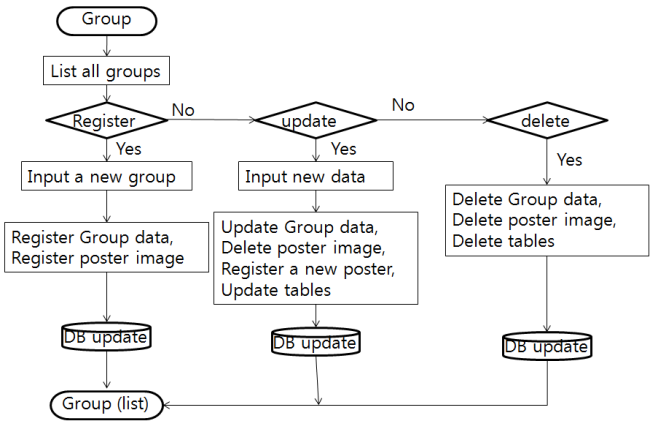

Figure 6. The 'Group' process

The processes of "URL/IMG/Live/VoD", "Subscriber", "Content Price", "Notices", "News", and "Administrators" are very similar to the "Group" process shown in Figure 6: detailed descriptions of them are omitted.

The "Log of Administration" provides search and delete functions. This menu displays all of the administrators and a search window. Searches by ID, password, and date are allowed. After displaying the search results, it can delete selected items. The "Log of Administration" process is shown in Figure 7.

The "Management of News/Notice" process also starts with displaying all the attribute values associated with news and notices and allows administrators edit them.

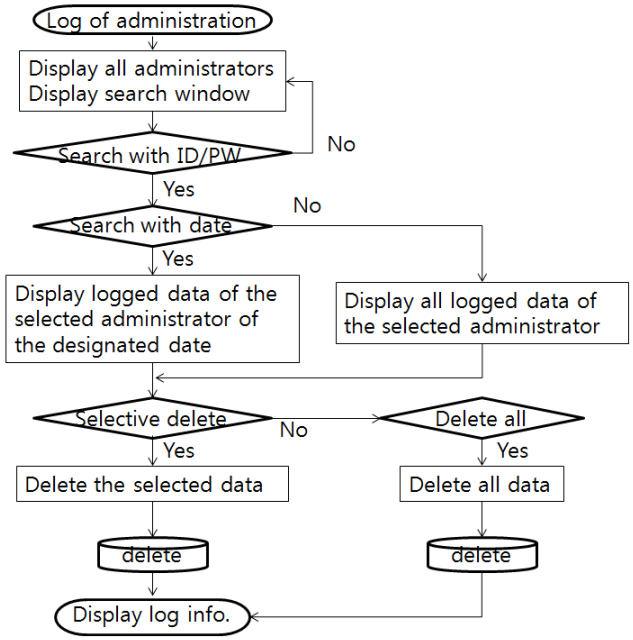

Figure 7. The 'Log of Administration' process

5. The Implementation

We implemented our broadcast management web system using the PHP language. The utility functions were done using separate files so that they can be included in many other PHP file applications. For example, db_connect(), qopen, db_rownum, db_fetch() and other utility database functions are defined in db.php. Using the default values of the DB server IP address, user ID, pass word, database name, and db_connect() returns the result of mysql_connect(). qopen($query) executes $query and returns the results. db_rownum($res) returns the number of rows of $res. db_fetch() executes mysql_fetch_array(), *i.e.*, db_fetch is an abbreviation of mysql_fetch_array.

Another library file is commonlib.php. file_upload, datediff (given two dates, returns the difference between them in terms of days), fetch_image_list, send_sms, and so on are defined in this file.

The login procedure (see Figure 4) is implemented as follows. It starts with executing 'session_start();' in order to create a new session or resume the session. Once this is done, all values in $_SESSION are consistently available on all of the linked pages until the current user logs out. So, we save UserID and TID (primary key) in $_SESSION as follows:

```
$_SESSION['MemberID']    = $row[UserID];
$_SESSION['MemberTID']   = $row[TID];
```

Our implementation of the beginning of the Main procedure is a direct translation of Figure 5 into PHP language; the remaining part (configuring a menu page) of it is implemented in PHP, HTML, and JavaScript. For example, the following is a part of the code used to configure the 'Contents Registration' menu item:

```
<? if(strstr($PAuthority,"Register & Transcoder")){  ?>
    <a href='content.php' target="mainsub2"><span class="style1">??/span> Contents Registration</a><br />
  <? }else{  …
```

As can be seen in the above code, content.php is the program linked to the menu. If "Register & Transcoder" is included in $PAuthority (*i.e.*, permitted to the user), then the menu is linked to content.php. Otherwise, the menu is disabled. Similarly, we link the "Content/Metadata Update" menu item to search_content.php, the "Service Statistic" menu item to Statistics2.php, and so on.

The category procedure shown in Figure 5 is implemented in category.php; it divides a form into two frames. In one of the frames, all of the categories are displayed in a tree. In the other frame, detailed information about the selected category is displayed. The procedure for the former is implemented in category_tree.php and the latter is implemented in category_mainsub.php.

The group procedure shown in Figure 6 is implemented in mdf_management.php. The following are sample sentences used to obtain parameter values:

```
$MDF = $_POST["MDF"];
…
$Mode = $_POST["Mode"];
```

As Figure 6 shows, we can register, update, or delete group information. The function to be executed is specified in $Mode. The program checks the $Mode value, as shown in the

following code, and performs the designated function. In this example, if $Mode is “ADD” then it checks if the new row already exists in the mdf_management table and insert a new row into the mdf_management table if it does not.

```
if($Mode=="ADD"){
    $query = "select * from mdf_management where MDF_name ='".$MdfName."'"  ;
…
$query = "insert into mdf_management (Administrator,T …
```

The ‘Log of Administration’ process is implemented in userlog.php. This procedure retrieves and deletes information from the member_log table. As this is done in mdf_management.php it also checks $Mode:

```
if($Mode=="DEL"){
$query = "delete from member_log where tid=" . $TID2 ;
```

The following is a part of codes to retrieve log information of a given user.

```
$query = "select * from memberadmin  where 1 ";
if($UserID!=""){
        $query .= "and UserID like '%".$UserID."%'";
}
if($UserName!=""){ $query .= "and UserName like '%".$UserName."%'";
```

6. The Experiments

A screenshot of the ‘login’ result is shown in Figure 8. It shows menu items. A few of them are disabled.

Figure 8. The ‘login’ screen

A ‘Category’ screenshot is shown in Figure 9. We can select a category in the tree and edit the information from the selected category.

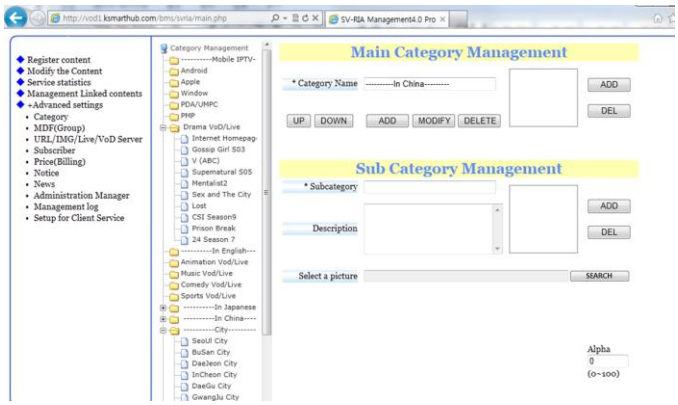

Figure 9. The 'Category' screenshot

A 'Group' screenshot is shown in Figure 10. We can register, update, and delete the group information. If we scroll down the screen, we will see a list of the groups.

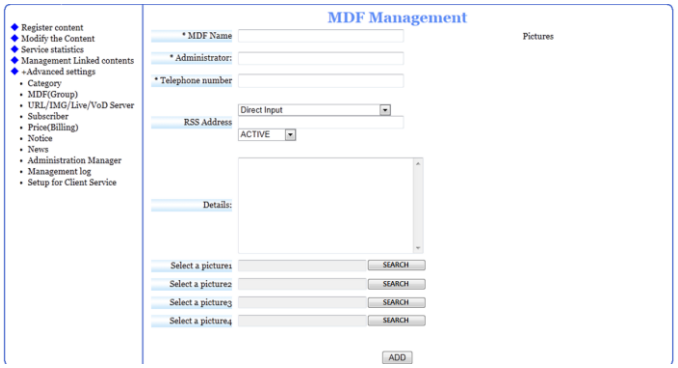

Figure 10. The 'Group' screenshot

A 'Log of Administration' screenshot is shown in Figure 11. We can search for an administrator and retrieve the logged information of the administrator from the database.

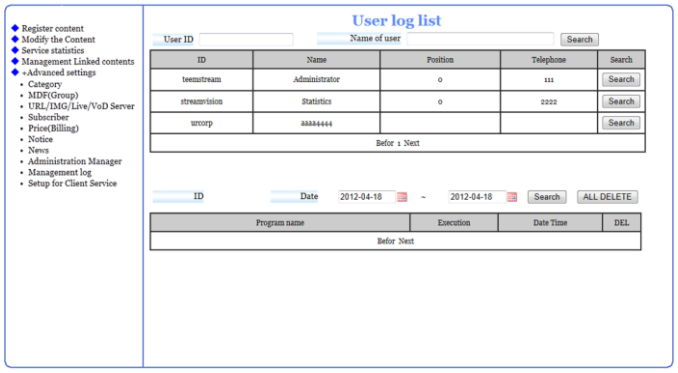

Figure 11. The 'Log of Administration' screenshot

7. Conclusion

This paper discussed our implementation of a broadcast management web system (BMS) for the 'Open IPTV System'. We analyzed the user requirements for the system and designed the system to meet these requirements. We then introduced our implementation of the design. Finally, our test results were discussed. Using this system, operators can access the BMS anytime and anywhere, as long as they are connected to the Internet.

In the database field, "CRUD" (create, read, update, and delete) is considered to be the set of operators that should be able to be performed on the information stored in a database. Our implementation provides these four operators for each of the information units.

Acknowledgements

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