A Web-based IPTV Content Syndication System for Personalized Content Guide

Jinhong Yang, Hyojin Park, Gyu Myoung Lee, and Jun Kyun Choi

Abstract: **In this paper, we propose a web-based content syndication system in which users can easily choose IPTV contents. This system generates personalized content guide to provide a list of IPTV contents with respect to user's interests and statistics information of their online social community. For this, IPTV contents and relevant metadata are collected from various sources and transformed. Then the service and content metadata are processed by user metadata including audience measurement and community metadata. The metadata flows are separated from content flows of transport network. The implementation of IPTV content syndication system demonstrates how to arrange IPTV contents efficiently from content providers to the end user's screen. We also show that the user metadata including online community information are important for the system's performance and the user's satisfaction.**

Index Terms: **IPTV, content syndication system, metadata orchestration, integrated content assessment.**

I. INTRODUCTION

CURRENTLY, users in the world enjoy more than 8 billion contents a day which are offered by either broadcasting channels or on-demand services. Because the nature of the two is different, most services provide them separately or by different manners except IPTV: they provide both linear TV and on-demand contents on the same platform. Here, we note that IPTV contents include live/recorded audio/video contents and all the types of web contents.

Providing variety of contents gives merits to users but how to manage them is a big challenge to the IPTV service providers. Just merging increases the number of contents to provide at least three times and the number keep increasing even rapidly. Different natures of the contents also need to be figured out and transformed for harmonious orchestration within a service. To cope with the massive amounts of contents, the content syndication structure for IPTV services should be well scalable for handling both contents and their metadata.

For the success of IPTV services, the key is to arrange contents to be easily selected by user's interests. Among the enormous contents, ones can be displayed on one screen is limited and that arrangement need to look attractive and persuasive. Here, the browsing and searching are important activities within navigation of IPTV contents [1]. From the metadata information of IPTV services, a layout of relevant descriptions with record and attribute information is also important.

There are the types of metadata for IPTV services; service and content metadata, user metadata, metadata for content provisioning and management, metadata for aggregation management, rights and security related metadata [2]. The performance of content syndication system is depended upon the effective utilization among user metadata and service/content metadata. Therefore, the outstanding issues are how user meta-data can be effectively processed with content metadata and produce service metadata.

In this paper, we propose a web-based IPTV content syndication system in which users can easily choose IPTV contents through personalized content guide. In order to do this, users have to send user metadata by explicitly notifying their preferences. Otherwise, the statistics of user behaviors should be allowed to collect by the IPTV service providers. The content access history and distribution of preferred materials are important to arrange the IPTV contents. Plus, the information on user's activity and the preference of the members of the online community are valuable sources, since the social interaction among large community affects to the user's choice on IPTV contents. Based on those metadata, proposed system performs cross content evaluation to generate integrated arrangement of the personalized contents.

This paper is focusing on handling service and content metadata from user metadata and the related information achieved from web. Firstly, the proposed content syndication system aggregates contents from both linear channels and on-demand services. Then, it orchestrates their metadata by transforming and filling in additional data semantically. With refined set of metadata, integrated content assessment and community activity reasoning based content composition is done for syndication and finally, the packaging for content arrangement on a screen is done. For modularity and scalability, the proposed syndication system is separated from the delivery structure of IPTV contents. Hence, we note that the actual locations of IPTV content sources and storage are out of scope in this paper.

The implementation results of the proposed system are demonstrated and recorded on [9] and [10]. The performances of proposed syndication functions are shown in terms of metadata interactions and related statistics information of online social community. The user satisfaction and hit ratio according to user metadata are also shown. In addition, the performance results on number of clicks while choosing an IPTV content are

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shown.

The remainder of this paper is organized as follows. In Section II, we describe the related works including standards of metadata. The web-based content syndication system including functional architecture is proposed in Section III. The personalized content guide generation using the proposed content syndication system is described in Section IV. The implementation results and performance behaviors of the proposed system are shown in Section V. Finally, the conclusion is followed.

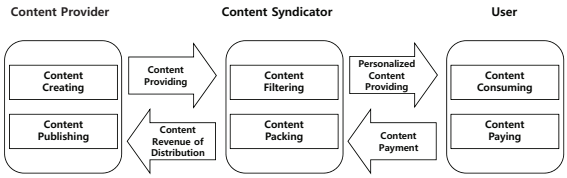

Fig. 1. Concept of IPTV content syndication model.

II. RELATED WORKS

According to the use cases of the IPTV services, there are broadcast services, information services, and communications services, etc [3]. Until now, the metadata for IPTV services are well defined only for broadcast services. The metadata are not well defined for information services and communication services. The media annotation and ontology for web contents have studied [4]. Yet, different metadata schema and encoding rules are available for web contents.

The metadata can be applicable for IPTV service discovery and selection [1]. The high-level metadata for IPTV services are well described in [2]. However, for web contents, there are a number of different metadata schemes such as CableLabs 1.1, Dublin Core, ID3, Media RSS, MPEG-7, OGG, QuickTime, TV-Anytime, XMP, YouTube Data API Protocol, etc [5]. Moreover, the encoding schemes and searching engine for web contents are not well tuned even though DVB (Digital Video Broadcast) has a standard for IPTV service discovery and selection [6].

To establish the value-chain of IPTV services, relevant negotiation among content providers, service providers and end users are needed. Before transferring IPTV contents to end users, the IPTV service provider should arrange the lists of IPTV contents for end users to easily choose one of them, for which IPTV service and content metadata are processed or sorted by end user metadata information. It notes that the service and content metadata are used for peoples to find, click and buy IPTV contents.

With the perspectives of IPTV service providers, the user metadata including audience measurement information are the primary factors to arrange the lists of IPTV contents efficiently and also reduce usages of resources. Currently, the end user metadata including audience measurement is not clearly defined yet. One of the reasons is that user metadata may include personal information and security concerns. In order to process user metadata, the user permission may be needed.

From the standard activity of ITU-T SG16, the audience measurement data consist of two components: user profiles which are user status description and end-user behaviors which are for user activities description [7]. User profiles consist of user information and system environment. User information is data of an IPTV user such as age, gender, and address. Also, there are system environment information of IPTV terminals such as device identifier and device configuration. The audience measurement information includes end-user behaviors consisting of "application events" and "user history" which are usually captured by end-user measurement function. "Application events" is information of audience measurement related application events such as "play a video" and "select channel 302". "User history" is information relating to the generation of "application events" such as the time when an application event takes places, the person who makes an application event and time duration of two application events.

In addition, the architectural design of the IPTV content syndication system to compose and convey the personalized IPTV service is important. According to [8], ITU-T classified the IPTV architecture into NGN-IMS (Next Generation Network - IP Multimedia System) based, NGN non-IMS based, and non-NGN based architectures and all of them can support IPTV personalization. [11] represents the advantages of the personalized IPTV services built on the NGN-IMS based IPTV architecture and describes the sessions flows for important use cases. On the other hand, [12] represents another functional architecture for NGN non-IMS based personalized IPTV services by embracing the concept of web-based open service platform. The proposed web-based IPTV content syndication system is built by leveraging the non-NGN based IPTV architectures for personalized IPTV service. The non-NGN based IPTV architecture does not provide any well-structured foundation for service, but it provides the most flexibility and autonomy. Note that the proposed system can be integrated with both NGN non-IMS based and NGN-IMS based IPTV architectures by taking its functional blocks into separate functions or application servers and putting efforts for integration.

III. WEB-BASED CONTENT SYNDICATION SYSTEM

According to a dictionary [15], syndication is defined as "the act or process of syndicating" where syndicating is "to pub-

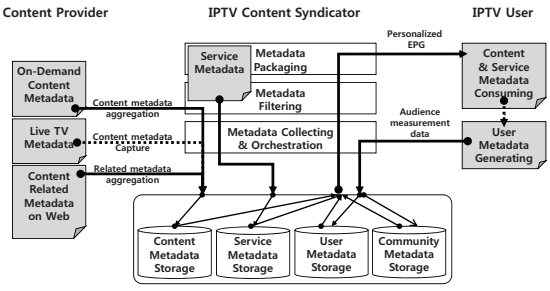

Fig. 2. Metadata generation and consumption on personalized IPTV content syndication process.

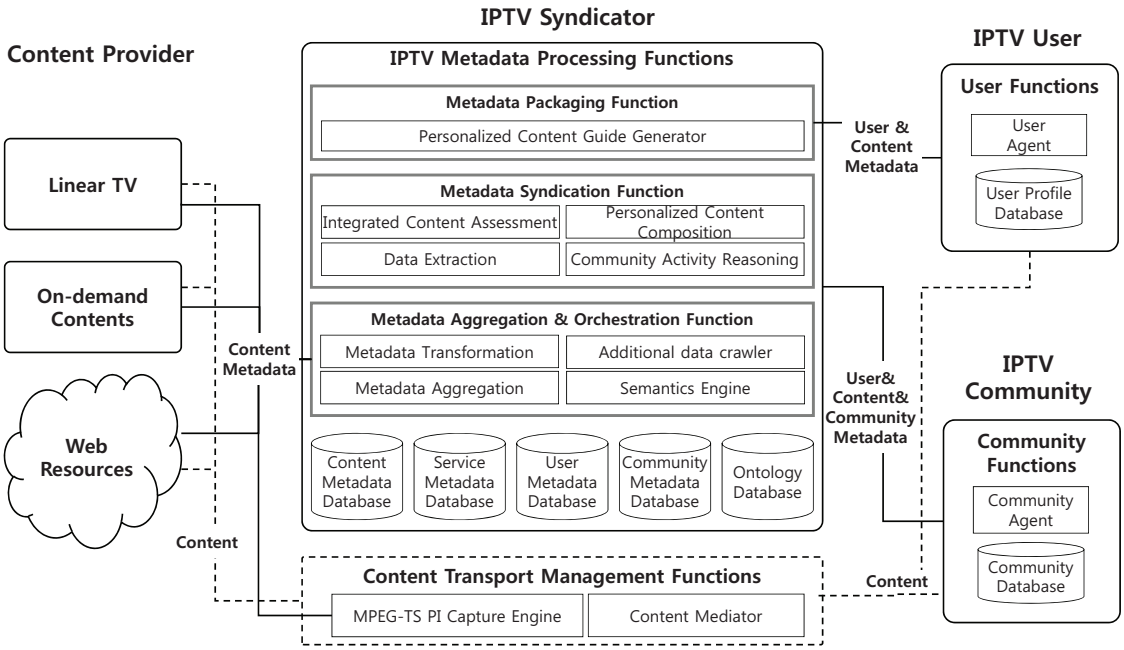

Fig. 3. Functional architecture of the IPTV content syndication system.

lish simultaneously, or supply for simultaneous publication, in a number of newspapers or other periodicals in different places: e.g., Her column is syndicated in 120 papers". This concept can be applied in IPTV service as well; IPTV also publishes the same content simultaneously on multiple user's screen as depicted in Figure 1 and 2. In this section, we describe proposed web-based IPTV content syndication system in order to provide personalized services through the syndication process on various types of contents using web technologies.

A. Content Syndication Model for IPTV Services

For the unified, efficient, and scalable aggregation on RMC (Ready-Made Content), PCC (Proteur Created Content), and UGC/UCC (User Generated Content/User Created Content), we adopt web as a platform. Most of the UGC/UCC or PCC are already successfully provided on the web and can accommodate RMC gracefully, while having the advantage of great interactivity and accessibility. In addition, the linear TV streams from broadcasting services can also be syndicated on the web under the support of proper delivery mechanism. Hence, the functions of the proposed system are provided either through web browser or Internet applications with web protocols and markup languages.

Basically, content syndication is the controlled placement of the same content on multiple partnering destinations in order to provide benefits to content creators, content publishers, advertisers and users. The content syndicator marked in Figure 1 is an agent that interconnects between content providers and users. Content providers provide contents and get revenue for content distribution, whilst users receive customized content and pay money for services. Content syndication model for IPTV services plays an important role in distribution through filtering, packing/bundling for various contents as a service platform to provide value-added services by achieving personalization.

B. Metadata Generation and Consumption for Content Syndication Process

In general content syndication process, besides the actual content, the metadata which describes about contents and services are generated, managed and used. For personalized IPTV services, additional information such as user's profiles and communities for social networks should be considered to support content recommendation and search based on user's preference and service usage. As shown in the Figure 2, user metadata and service metadata as well as content metadata are used in the syndication process for IPTV services. The syndicator for IPTV services performs collecting and transforming of metadata after content metadata aggregation and then provides filtering and packaging functionalities using three types of metadata to an IPTV user. According to user metadata including audience measurement data, IPTV user receives personalized content guide and consumes IPTV contents. User metadata including audience measurement data created in the content consumption process are transferred to the syndicator again. The transferred metadata information is used as a base data for more correct content recommendation to support personalization.

C. Functional Architecture of IPTV Content Syndication System

IPTV content syndication requires interactions among content provider, IPTV syndicator, IPTV user and IPTV community for the processing of content and related metadata. Figure 3 shows the functional architecture to implement proposed IPTV content syndication system to specify roles of each domain. In Figure 3, there are four functions as follows.

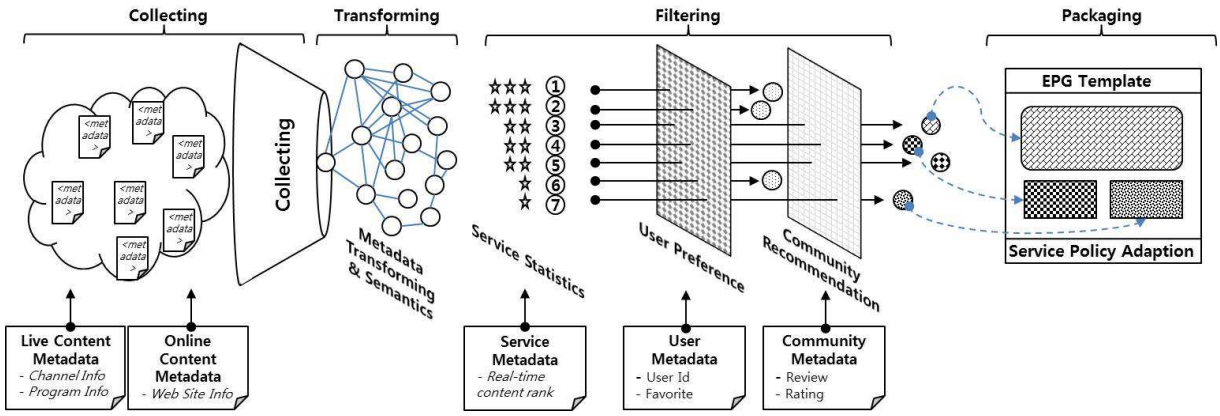

Fig. 4. Personalized Content Guide generation process.

– **IPTV Metadata Processing Functions** IPTV syndicator is a core part for IPTV content syndication. It consists of the three functions and five databases. The Metadata Aggregation and Orchestration Function performs aggregating, transforming, and additional data crawling semantically. The Syndication Management Function extracts data from managed metadata databases and performs integrated content assessment. Then, it composes personalized contents by reasoning with the online social community metadata. The Metadata Packaging Function generates personalized content guide by arranging and composing available contents by their weights in accordance with service policies. The databases contain information on content metadata, service metadata, user metadata, community metadata and ontology.
– **User Functions** The User Agent executes the IPTV applications and services following the commends occurred from navigations and requests. It also records the user's service usage and transfers them to create or update the service and user metadata so that the IPTV syndicator can keep tracking the users' preferences.
– **Community Functions** The Community Agent collects and transfers community statistics regarding the community members' preferences on contents and the activity or interactions taken by the users.
– **Content Transport Management Functions** This function manages both linear broadcasting channels and on-demand content delivery including required transformation for each user. IPTV content distribution and provisioning for efficient transmission is also controlled in this function.

IV. PERSONALIZED CONTENT GUIDE GENERATION PROCESS

In the proposed web-based IPTV content syndication platform, personalized content guide generation is done by recursive way of metadata generation, collection, and management. Figure 4 shows a personalized content guide generation process in the proposed IPTV content syndication system. There are four key steps: collecting, transforming, filtering, and packaging. Content and metadata for live contents, on-demand contents, and on-line contents are collected and transformed for integrated assessment. Filtering is done by applying service statistics, user's preference and community activity data to the semantic content metadata. Finally, extracted metadata are packaged into a personalized content guide followed by the service policy.

A. Metadata Collection & Transforming

Metadata collecting and transforming is done by the Metadata Aggregation & Orchestration Function in the Figure 3. The Metadata Aggregation function collects content metadata from various sources including content providers. Since existing web-based content providers have their own content publish channels, we adopt the web-based content syndication method which supports RSS (Really Simple Syndication)/ATOM to accommodate content publishing environments of content providers without modifications.

The Metadata Transformation function then performs the format conversion and rule mapping for integrated metadata assessment which are one of the important steps for orchestrating diversity of the contents and metadata. The content metadata as well as the user metadata and the community metadata are classified and transformed according to the management policy of the syndicator. The implementation of the rule-based metadata mapping procedure is shown in Figure 5. In this figure, XSLT (Extensible Stylesheet Language Transformations) are done for metadata format to be transformed into a customized form, in which the mapping rules are depending on the input and the output of each metadata.

B. Metadata Filtering

This step is done by the Syndication Management Function in the Figure 3. The Metadata Extraction function extracts all kinds of required or requested metadata from the databases.

Then the Integrated Content Assessment function performs evaluation, assessment, weighting, or filtering with proper algorithms. Especially, the community metadata collected from the Community Agent in the user's side and then generated from the Community Activity Reasoning function feeds good factors to examine the user's preferences. The Community Activity Reasoning function also decides which community or which users to recommend on the personalized content guide. Finally, the Personalized Content Composition function groups contents for

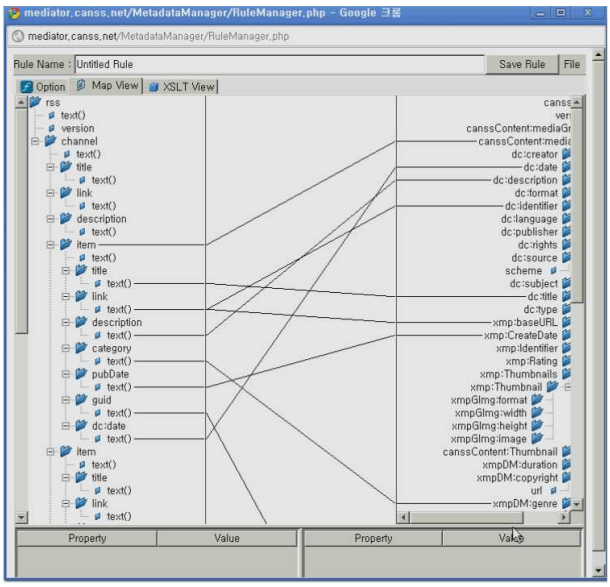

Fig. 5. Rule mapping for transforming of RSS Feed based content metadata.

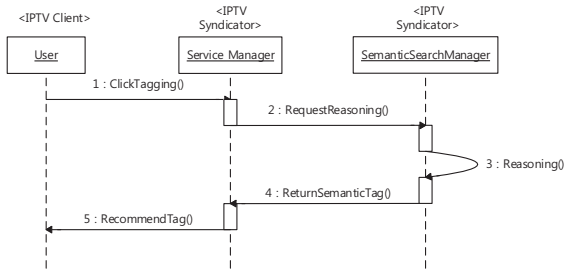

Fig. 6. Personalized content composition procedure.

packaging.

Note that the IPTV content recommendation algorithms or the filtering schemes [16–27] can be used in this step is likely to be more than one. IPTV service offers different kinds of contents and they cannot be examined by a recommendation algorithm. Usually, that difference shows better performance with different schemes. In addition, the methods for personalization keep evolving. For this reason, one of the key requirements on designing the proposed web-based IPTV content syndication system was to be able to accommodate various methods that can help to make the content guide become the more attractive and personalized.

Although keyboard inputs are limited in an IPTV terminal, a useful tag is easily recommended to a user effectively in order to search related contents. Through the content guide, proposed system provides a user interface in the form of Tag Cloud [30] to enable customized tag selection on the content guide. Semantic Search Manager [29] performs reasoning to recommend a list of appropriate tags based on the user's characteristic and semantic information as shown in Figure 6.

C. Metadata Packaging

Metadata packaging configures a personalized content guide using the metadata refined through previous process. During this process, user interface layout polices of service provider are applied. And then, content guide manager configures contents as a program with schedule like a live IPTV contents. In this way, on demand contents and live streams including broadcast channels can be browsed in one screen concurrently. Then, the programs are displayed on the content guide template to be provided to the user.

V. EXPERIMENTS AND PERFORMANCE RESULTS

In this section, the implementation results of the proposed IPTV content syndication system are shown. First, we show the configuration for field test trial. Second, we summarize the performance results on experimental testbed on reflecting user's preferences. The number of clicks to get the right contents is shown according to user history being accumulated. Third, the performance impacts on filtering and packaging functions of service metadata based on user metadata are analyzed. Finally, the performances on audience measurement information of social community are shown in form of social graph.

The target field test trials for demonstration are done at campus environments at the web site http://portal.canss.net/. The site is not running anymore but the video clips had taken to capture the implementations of both IPTV syndicator and the client side screen had been uploaded on the [9], [10].

The IPTV contents used for the test are the public broadcast channels, the on-line lecture materials, the collective video clips from the Web, and social media via web pages. The proposed content syndication system is not harmful on existing IPTV service providers and content providers since no processing on IPTV content itself is taken. The proposed system handles metadata only including audience measurement information.

Figure 7 shows the initial screen of the web-based IPTV content syndication system when a user logs in the web site. With this screen, an end user can set their primary preferences and the audience measurement is taken with this information. If a user joins an online social community with his/her interests, the related social statistics information are also collected. The user metadata including audience measurement information are stored in the user metadata database of the propose syndication system.

Figure 8 shows the aggregation procedure of the content metadata from live broadcast channels, on-line lecture materials, and web pages. Some metadata on the web are transformed in alignment with the storage structure of content metadata.

When a user logs in his/her web site on the proposed syndication system, the user can get the initial screen with linear broadcasting content schedule recommendation of live IPTV contents as a default mode as shown in the Figure 9, using the TV program recommendation scheme described in [16]. Then the user can change the channels or browse other contents on the personalized content guide.

In order to get the hit ratio of personalized content guide, the proposed content syndication system had been installed at campus domain during 6 months. Table 1 shows the accumulated

Table 1. Experimental result on hit ratio according to types of metadata.

Test Set No.	Types of Metadata					Experiment Results		
	Content Metadata	User Metadata	Community Metadata			Average number of click count	Average ratio of running time over total play-out time	Average number of moves during a session
	Parameters of Metadata							
	Content metadata with Semantics	User profile with audience measurement	Familiarity	Favorability	Similarity			
1	O					23	23 %	12
2	O	O				15	40 %	7
3	O	O	O			11	53 %	5
4	O	O	O	O		8	51 %	5
5	O	O	O	O	O	6	45 %	6

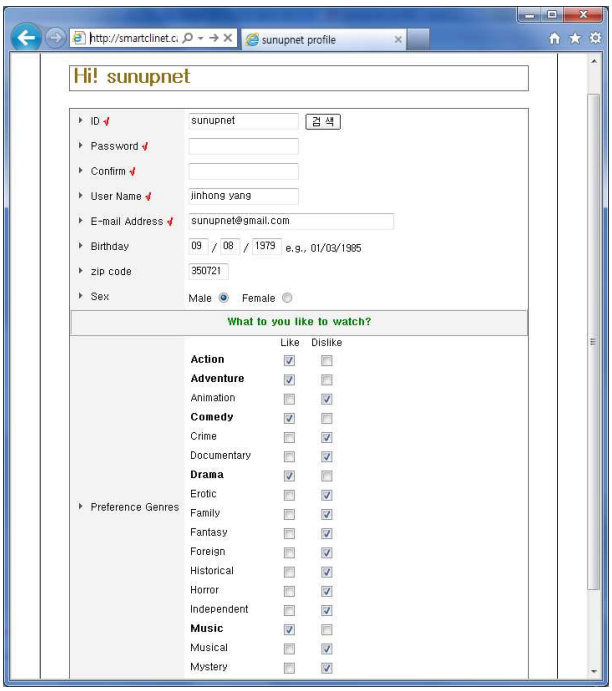

Fig. 7. Screenshot of the initial configuration for web-based IPTV content syndication system.

performance results of the personalization. In order to increase the hit ratio, i.e., decreasing the number of clicks take before a choice of play is made, the five steps of the metadata filtering schemes are applied gradually. Firstly, the content metadata with semantics is used to figure out the relationships between contents (e.g., series, re-play, remake, etc.). Then the service metadata is used to order the contents by their popularity. This popularity is calculated in three different periods (i.e., long, short, and real-time) and weighted differently to reflect the timeliness. Secondly, the user metadata from both user's profile and the audience measurement is used to weight the contents that are in user's preferred genre or related with user's viewing history. Thirdly, the community metadata is used to weight the contents that have been watched and recommended by most frequently interacting members (i.e., named as familiarity) among their communities. Fourthly, once more, the community metadata is used to weight the contents that have been watched and recommended by the most favorable member who doesn't response back but the user adores and keeps tracking for updates (i.e., named as favorability). Finally, the collaborative filtering is used to weight the contents that might be preferred by the user (i.e., named as similarity).

In the Table 1, the Test Set No. 1 shows the personalization results without applying the user and community metadata information. It reflects the IPTV service only utilizes the content metadata information. In this test, average number of clicks is 23 times when an end user finally chooses and clicks an IPTV content among all the available IPTV contents on user's screen. Also, an end user enjoys an IPTV content less than 22 % of total play-out time since he/she stops to play-out the content and change or browse for other contents. During a session, a user enjoys to move other contents with average 12 times. Test Set No. 5 shows the recommendation results with full knowledge of metadata of user and community. The average number of clicks to choose an IPTV content is 6 times. Average ratio of running time is nearly two times higher than that of Test Set No. 1. The average number of moves during a session is 6 times. This result shows the impacts of user metadata and community metadata.

Table 2 shows the impacts on user history during the content recommendation. It shows the impacts on content recommendation when history information of user statistics is accumulated. This result had been accumulated while all the metadata infor-

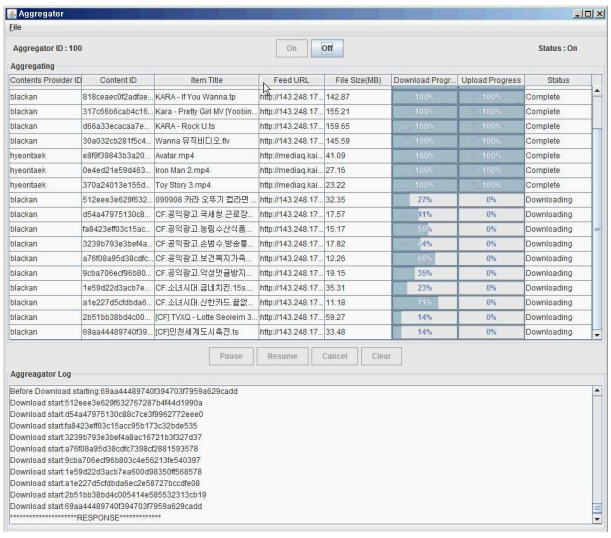

Fig. 8. Screenshot of the content metadata aggregation process.

Table 2. Number of Clicks according to user history.

	1st Month	2nd Month	3rd Month	4th Month	5th Month	6th Month
Medadata Transactions	10019	8928	5138	3854	3071	2748
Accumulated Records of Metadata Transactions	10019	18947	24085	27939	31010	33758
Number of Clicks (Monthly Avg.)	**18.2**	**14.1**	**9.5**	**7.2**	**6.1**	**5.9**

mation is used with the five steps of filtering schemes and the broadcast schedule recommendation. At the first time of joining the IPTV syndication system, the average number of clicks to choose an IPTV contents is around 18 times. 6 months later, the average number of clicks decreases down to 6 times. Even though the results of Table 1 and 2 are depending on the layouts of the user screen and number of contents, the overall performance behaviors are meaningful.

Figure 10 shows the user interface of the social network browser, named as SN browser, with social recommendation from community. By using the social network browser, users can navigate through a group of users who have similar interests, and access contents organized by other users. The radial distance from the user (positioned in the center of the circle) to the other users reflects the similarity of their interests. In addition, the users can create a new IPTV community by inviting other users in the social network.

VI. CONCLUSION

In this paper, we have proposed the web-based content syndication system for personalized content guide that enables syndication packaging on all categories of contents according to metadata. In alignment with global standardization of IPTV, we have tried to develop a way to accommodate the web-based contents more conveniently and harmoniously. Being aware of large amounts of IPTV contents and trends of social media, the proposed system is very important especially for handling user metadata including audience measurements.

For performances of the proposed system, we have demonstrated that the coordination among service and content metadata as well as user metadata is needed to increase searching speed and reduce usages of resources. By the actual implementation to see the impact of user metadata and community metadata, we have shown that there is trade-off between simplicity of user screen and accuracy of user metadata as well as that the accuracy of user metadata including audience measurement information is depending on type of IPTV contents. In our experimental results, we conclude that the impact of user metadata is significant when users and social community have similarity and familiarity on their preferences.

To cope with upcoming traffic volumes of social media, the importance of the user metadata including community metadata will significantly increase in order to arrange the user's screen efficiently. Therefore, we expect that the proposed content syndication system will be introduced at the real market, and will lead to more demands for the web-based contents.

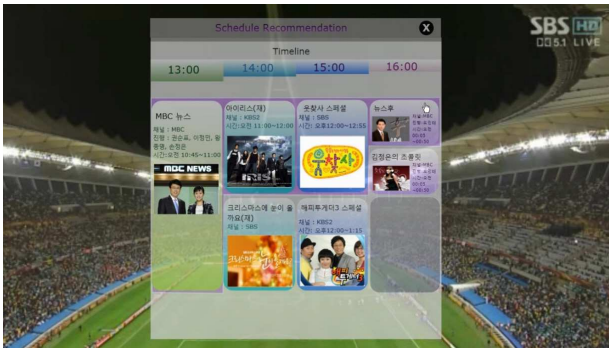

Fig. 9. Screenshot of the user interface for broadcasting schedule recommendation.

Fig. 10. Screenshot of the user interface for social relationship-based media consuming environments.

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