

A Dynamic Downloadable Service Discovery System compatible with the DVB-SI based EPG Applications

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Abstract—this paper proposes a downloadable service discovery system compatible with the current deployed EPG applications based on DVB-SI for program guide. The SD&S (Service Discovery and Selection) and BCG (Broadband Contents Guide) are the xml-based standards approved by ETSI to deliver metadata of digital broadcasting services over broadband networks. The SD&S/BCG has been strongly recommended as new standard for IPTV service discovery and selection protocol in many countries. However, most of service providers use DVB-SI for their EPG (Electronic Program Guide) application running on already deployed Set-top boxes, and this is one of big problems to publish IP-optimized service platform. Therefore, this paper proposes a dynamic downloadable SD&S/BCG-based service discovery system which supports current-deployed EPG applications using DVB-SI without modifications

Keywords— EPG, SD&S, BCG, IPTV, DVB-SI, Metadata

I. INTRODUCTION

IPTV is considered as a symbol of digital convergence era. DBS(Digital Broadcast Service) has been provided through other media such as terrestrial, cable and satellite networks thus far. However, the high bandwidth of IP network makes it possible to provide DBS over broadband network [1].

Traditionally real-time broadcast streams of DBS are delivered through MPEG-2 Transport Stream (TS), which is tightly coupled with audio, video, metadata, and applications. The MPEG-2 TS is optimized to unidirectional media because it was developed to multiplex all components into one stream, packetize the stream, and transport TS packets one-sidedly [8]. In contrast, a broadband network is bidirectional and user can obtain metadata or applications directly from the application server or web site at any time. Moreover, a broadband network has useful multimedia streaming protocols such as UDP and RTP, thus there is no reason to use MPEG-2 TS in the transmission of DBS over IP because it does waste more time and bandwidth.

Recent researches from ITU-T IPTV Focus Group, DVB-MHP, and DVB-IPI show movements of replacing MPEG-2 TS with IP-oriented protocols for DBS in IPTV [1],[7].

This paper describes the architecture to support service discovery and selection compatible with DVB-SI based EPG applications run on current deployed IPTV set-top boxes.

II. RELATED DIGITAL BROADCAST STANDARDS

Legacy Digital Broadcasting Services are delivered as MPEG-2 TS streams multiplexed with audio, video, metadata, and applications. Open standards such as ACAP, OCAP, and MHP define the specification for handling service information regarding service programs, program events, and so on. For example, ACAP and OCAP use Program and System Information Protocol (PSIP) and MHP uses DVB-Service Information (SI) to describe service information tables [2], [3].

Real-time broadcast streams may contain service information tables as well as audio, video and applications.

GEM was produced by the MHP Umbrella Group of DVB to harmonize middleware system with the aim of promoting application interoperability, making it possible to write an application once that will run on any GEM-based terminal. OCAP adopted the GEM for its applications; and ACAP, ARIB and BD-J (Blue-ray Disk Java) then adopted it as their datacasting standard [4], [5].

DVB-IPI also supports MPEG-2 TS based DVB services over IP as well as XML-based service discovery and selection (SD&S). Moreover, DVB-IPI uses the TV-Anytime to explain service, program's detail information, more information is described in BCG(Broadband Contents Guide) and DVB-IPI [1],[9]. TV-Anytime is defined for PVR to find contents using XML-based metadata, and record them on time [10].

DVB-MHP1.2 includes XML-based application signalling to support MPEG-2 TS-based DVB services over IP using SD&S [3]. AITs for both of bound applications and unbound applications are described in XML documents of SD&S, and delivered via HTTP or multicast protocols defined for SD&S.

III. ARCHITECTURE

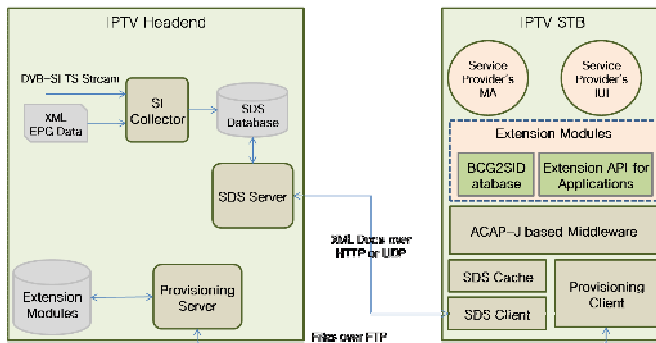


Figure 1. Dynamic downloadable service discovery architecture

Figure1 shows the architecture of dynamic downloadable service discovery system. The server-side head-end system is composed of SI (Service Information) collector, SDS (Service Discovery and Selection) server, and provisioning server. IPTV STB consists of provisioning client, SDS client and ACAP-J (Advanced Common Application Platform-Java Profile) based IPTV middleware.

Provisioning client connects to provisioning server to install extended modules over standard IPTV platform to support service provider's own applications during IPTV STB booting time. SDS server transmits SD&S/BCG based service information to SDS clients using HTTP or multicast protocols, service provider's own EPG applications access those service information with traditional DVB-SI Database APIs. The downloaded extended modules support those APIs by converting SD&S/BCG based service information into DVB-SI friendly data internally.

By this, service provider's EPG applications currently implemented can be supported until new EPG applications are developed and deployed.

A. IPTV Terminal Provisioning

When IPTV STB is booted-up, IPTV STB and user authentications should be processed to prevent users without proper rights access to services. All standard STBs contain PM (provisioning management client) to attach service provider's provisioning server. After device and user authentication step is finished, PM client use the default address configured in STB or address received from DNS server to connect the provisioning server. PM server is a daemon listening to provisioning port, and it processes any client's request of provisioning step.

Configuration file is stored in provisioning server's database which describes all information of service provider like addresses of all servers, default EPG channel, applications and extension modules. First of the all, the configuration file is downloaded from provisioning server using TR-069 based messages, then IPTV STB sets up configuration information according to the configuration file, and downloads and installs the extension modules over IPTV standard middleware (ACAP-J), and applications for

terminal management and value-added services are downloaded and installed lastly.

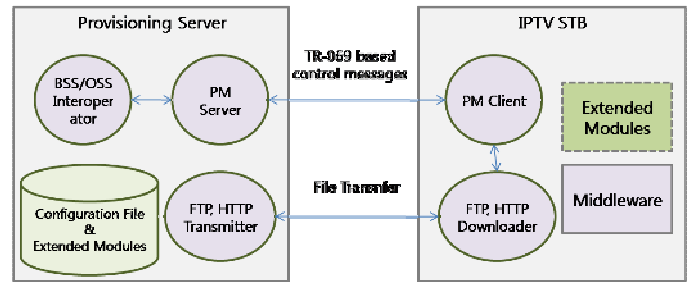


Figure 2. Provisioning architecture to download extended modules

During downloading and installing extension modules, SDS-related modules which supports already deployed EPG applications are installed. HTTP or FTP is used to transmit configuration file and extension modules including applications. TR-069 based messages are defined to communicate between PM server and PM Clients. There are also BSS/OSS servers in service provider's server farm; they do functions from subscription to billing etc. BSS/OSS separates to provisioning server, and it doesn't need to define interfaces between BSS/OSS and provisioning server. It is up to service providers to support interface between BSS/OSS and provisioning server using their own protocols.

B. Service Information Server

1) Service Information Collector

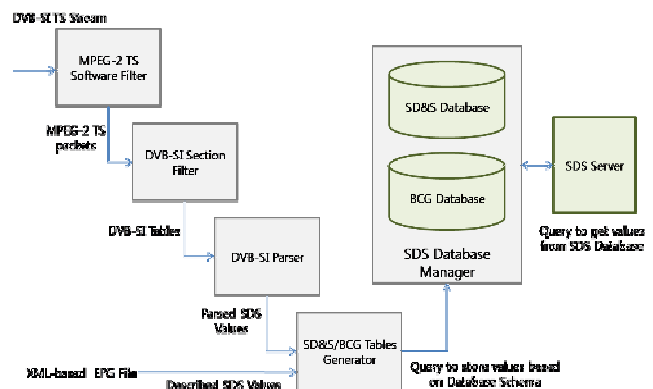


Figure 3. Service information collector Structure

SI (Service information) collector analyzes service information described in an XML document or multiplexed into MPEG-2 TS streams, and generates records of SD&S/BCG database using SQL. MPEG-2 TS stream is used to support deployed EPG applications temporally until all EPG applications will access service information based on new standard (SD&S/BCG).

MPEG-2 TS software filter receives MPEG-2 TS stream by per 188 byte packet unit, and passes non-PES packets to DVB-SI section filter, and then DVB-SI Section Filter extracts only EPG-related sections such as NIT, SDT, EIT, and then DVB-SI parser is used by SDS generator to parse those tables and to produce SD&S/BCG records. Generated SD&S/BCG records

are classified into 6 tables, that is, SPD (Service provider discovery), BD (Broadcasting service Discovery), BCG (Broadband Contents Guide), SI (Service Information), PI (Program Information) and PL (Program Location) tables. All records are stored to two databases (SD&S database and BCG database) in time-based by SQL queries.

Service provider's SD&S tables include information related with service providers like service list (broadcasting services and contents guide services) and service provider's name etc. BCG tables include data about contents like schedules, titles, genres, synopsis and unique ID etc. These data is defined enough to support both of SD&S/BCG standard and DVB-SI tables. In fact, a lot of data defined in DVB-SI are also defined in SD&S/BCG schema, it is not problem to include DVB-SI in SD&S/BCG based SDS server. However, many service providers want to use their own private data for value-added services, therefore, it should be allowed for service providers to extend SD&S/BCG schema to include private fields. The modules to analyze those private data described in XML documents should be downloaded and installed over standard middleware during IPTV terminal provisioning time.

2) SDS Server

The SDS server consists of SDS database management system, SDS processor, Web EPG server and Multicast EPG server, and the multicast EPG server transmits xml documents to clients through broadband network periodically using DVBSTP (DVB SD&S Transport Protocol) over UDP.

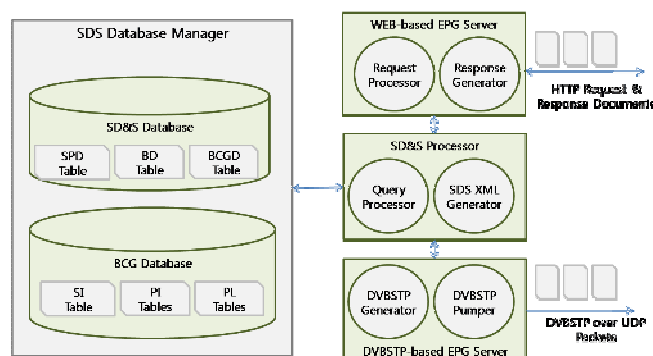


Figure 4. SDS Server Architecture

Web EPG server accepts client's requests to access SDS database management system, and processes clients query contained in HTTP requests to find SDS data, and get wanted data from SDS processor. SDS processor accesses SDS database system based on user queries, and generates SD&S/BCG documents using extracted records, and then passes those documents to Web EPG server or Multicast EPG server to transmit them to clients.

Multicast EPG server stores generated SDS XML documents to its own buffer after DVBSTP generator fragmented them into a series of DVBSTP packets. Whenever SDS database is updated, SD&S processor notify multicast EPG server to update the stored packets. The

updated packets are allocated with new versions as well as new data to be distinguished by clients.

When IPTV STBs are booted, they join the dedicated SD&S channel to get SD&S/BCG documents for SDS information. First of all SPD documents are received to analyze which services are provided by service providers, and then BD is received to analyze broadcasting services provided by service providers. When BD is analyzed, IPTV STB can know the list of channels and contents providers' information, therefore users can channel zap at this time.

IPTV STB should receive BCG documents to analyze more detail information of services and programs compose the services according to their own schedules. BCG shows the list of contents guide documents and their locations, IPTV STB requests those documents of SDS server to analyze program information and locations.

Service Information Fragment table contains more detail information of IPTV services like title, genre, contents provider's name, logo, logical channel number and region control code etc. Program Information Fragment table contains detail information of all programs contains in each services such as program name, genre, resolution, running rating control, synopsis, credits and descriptions etc. Program Location Fragments table includes schedules of programs associated with programs in Program Information Fragments table based on CRID (Contents Reference ID). Service ID is used to associate programs in PL (Program Location) Fragments with services in SI (Service Information) Fragments.

C. SDS Client

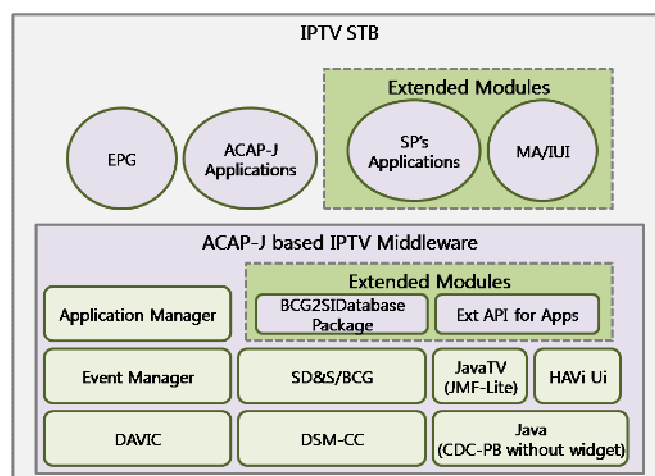


Figure 5. IPTV STB protocol stack

EPG applications display the SDS information as a friendly format to users, and the users navigate IPTV services. When user select a service to play, service ID is passed to middleware to join the address of selected service, and middleware set DTV chip-set with PIDs of audio and video to display AV as soon as possible.

EPG applications can be embedded in IPTV STB or downloaded from service providers during provisioning time after user turns on IPTV STB. Embedded EPG implemented to

be run on ACAP-J based IPTV standard middleware, so it can't analyze service provider's private data contains in SDS documents. Moreover, service providers want to control and monitor IPTV STBs connected to them, therefore they upload system applications like monitor applications and IUI (Integrated User Interface) application as well as applications for walled-garden services during provisioning time.

Although there are needs of new standard for service discovery extendible to include various services as well as broadcasting services, the expenses to develop new applications to support new standards has become big obstacles. So, extended modules downloaded to clients during provisioning time solve the problems allows already deployed EPG applications to use traditional SI access APIs without modifications.

Figure 5 shows the functions of IPTV STB excludes operating system, network and provisioning protocols. The details of functions are described. Extension modules should be implemented using only standard APIs defined in ACAP-J based IPTV middleware to confirm that those modules run properly regardless of STB manufactures and middleware developers.

D. SD&S/BCG based DVB SIDatabase API

Figure 6 shows flows of SDS data from receiver to EPG applications. DVBSTP receiver or HTTP Receiver receives SD&S/BCG documents, SD&S/BCG parser analyzes them, and generates SDS data such as Service Information classes, Program Information classes, Program Locations classes and Single Services classes (these are generated from Broadcasting Discovery document) to be stored to SDS cache. 3rd-party EPG applications access SDS cache using standard APIs defined in stored classes, but deployed service provider's EPG applications access SI cache using only DVB-SI Database APIs.

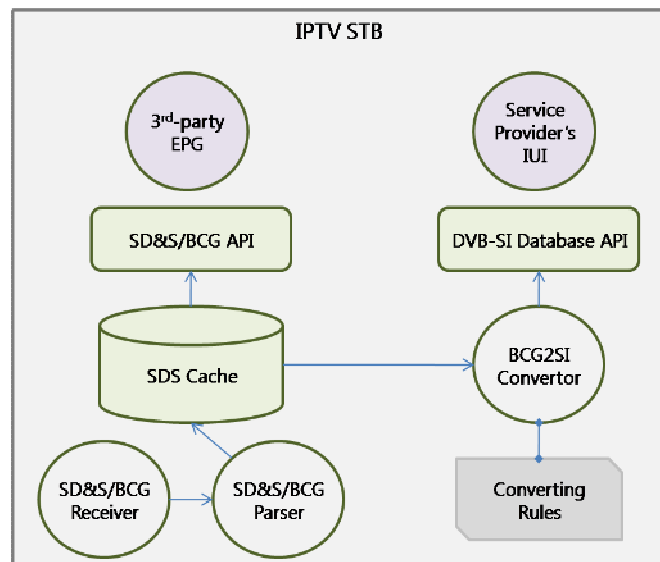


Figure 6. SDS client architecture

Traditional DVB-SI database APIs are defined to get and monitor SI tables multiplexed into MPEG-2 TS streams, so almost of all fields in DVB-SI tables and PSI (Program Specific Information) tables can be extracted from those APIs.

BCG2SI converter is the engine to support DVB-SI database APIs by converting SDS data into DVB-SI tables using rules described in table 1.

Table 1. Rules to convert DVB-SI Tables to SD&S/BCG Fragments

DVB-SI	SD&S/BCG	Convert Rules(DVB-SI to SD&S/BCG)
SDT	BD, SI,	-Service ID field is used to define Service ID in BD & SI -Service descriptor is used to define Service Name in BD & SI -Genre descriptor is used to define Genre in SI -Country Code descriptor is used to define country code in BD -Free CA field is use to define Scrambled in BD -Running Status field is used to define RST in SI -Extended Service Descriptors are used for SI to support private data
NIT	BD	-Extended Network Descriptors are used for BD to support private data -Transformation Stream Info. Is used to define Multicast Addresses of BD -Network descriptor is used to Domain name of BD
EIT	PI, PL	-Event ID field is used to define CRID of PI, PL -Start Time field is used to define start of PL -Duration field is used to define duration of PL -Short event descriptor field is used to define name of PI -Genre descriptor is used to define genre of PI -Content descriptor is used to define synopsis of PI -Short Event Descriptors is used for PI to support private data -Extended Event Descriptors is used for PI to support private data
PMT	SI	* SI's Stream Information Element is used to generate PMT and Elementary descriptors requested by DVB-SI database API

When EPG applications call `org.dvb.si.SIDatabase.getInstance()` to get default `SIDatabase` instance to access SI tables, `SIDatabaseManager` (a class of `BCG2Converter`) is returned. `SIDatabaseManager` provides functions to create tables and descriptors requested by `SIDatabase API` like SDT, NIT, EIT and PMT tables using SDS data (Elements in SD&S/BCG documents).

`SIServiceImpl`, `SIEventImpl`, `SINetworkImpl` classes are defined in `org.etri.dvb.si` to represent SDT, NIT, EIT, and generated in `SIDatabaseManager`, and then used by EPG applications using `SIDatabase APIs` internally. These tables can be extended to include service provider's private information, and only downloaded EPG application's parser function can detect and display it to users.

IV. IMPLEMENTATION

In this paper, IPTV STB emulator is implemented on a PC to test the dynamic downloadable service discovery system. The STB emulator consists of PGL (Porting Glue Layer of Panel, Tuner, Remote controller and screen devices), provisioning client, SD&S/BCG client and xlet viewer for launching IPTV standard applications.



Figure 7. IPTV STB emulator

The xlet viewer uses ETRI IPTV middleware(ACAP-J based) for testing xlets extracted from MPEG2-TS or downloaded from provisioning server.

The STB emulator is connected to the test-bed of one Korean IPTV service provider which provides live broadcasting channels and some applications for value-added services. The provisioning clients download extended modules and applications from provisioning server implemented as a prototype. Our provisioning server includes the service provider's MA/UI (Monitor Application, Integrated User Interface application), other applications and extended modules which support these applications to run over ACAP-J based middleware.

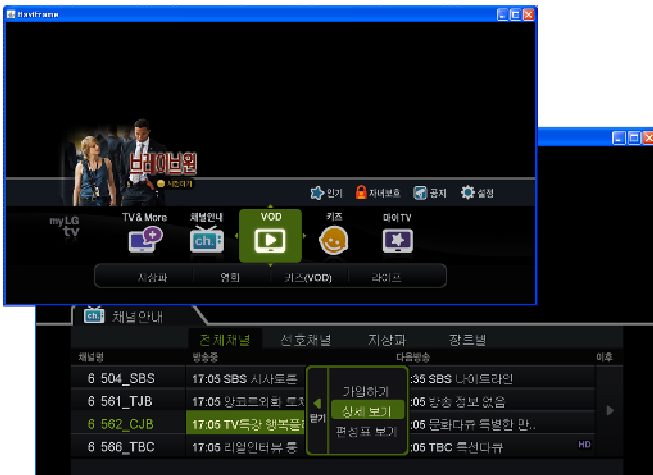


Figure 8. Captured IUI screen shot

SDS server converts DVB-SI streams of the service provider into SD&S/BCG documents in real-time, and the STB emulator receives the documents via HTTP or DVBSTP based receiver.

IUI uses DVB-SI Database APIs to access service information provided by service provider, and figure 8 shows IUI runs correctly without modification under SD&S/BCG service discovery system.

V. CONCLUSIONS

IPTV is a "hot spot" of the digital convergence era, and digital broadcast services can be considered as its "killer service". This paper proposes the architecture to support service navigation and selection based on the SD&S/BCG of DVB-IPI. Moreover, Dynamic downloadable SDS architecture consists of provisioning server, SI collector, SDS server and BCG2SI converter is proposed to support already deployed EPG applications. The architecture helps service providers reduce expenses to adopt IPTV standards by using current applications as they are. This also might cause to advance the era of open IPTV services with rich contents and sources which can be accessed by standard IPTV STBs.

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