Xlet-based, IESG(Integrated Electronic Service Guide) in Ubiquitous Interactive TV Environment

Ho Yeon Jang † and † Nammee Moon †,

Digital Media Lab.,Seoul University of Venture & Information, South Korea

Summary

This paper discuss the outline of effective Integrated Electronic Service Guide(IESG) system and service in ubiquitous interactive TV environment. Recent interest in ubiquitous digital television broadcast is business model related to interactive and enhanced application running on digital TV platforms. EPG is the core digital television service of which primary function is to provide viewers with overview and schedule information of the current or upcoming television programs(transmitted in broadcast transport streams). IESG service is designed to compose Electronic Program Guide(EPG), interactive TV service information such as TV portal service and genre information in interactive TV platform. Interactive TV platform includes ATSC-ACAP, OpenCable-OCAP and DVB-MHP. This platform is a Java based data broadcasting standard for interactive TV service through digital TV set-top boxes. To make it possible, broadcasters have to transmit program scheduling information and interactive TV service information. However, each broadcasters adopting each other standard in the same country transmit only their own program guides, not those of other broadcasters because of lack of bandwidth and other business issues. In this paper, we discuss an effective way of IESG service implementation in which, based on Xlet-based, service information standard is used to display a broadcaster's own channel program guide, and Return Channel is used for the program guide and interactive TV service information of other cross media in ubiquitous digital TV environment.

Key words:

EPG, ACAP, MHP, OCAP, Digital TV, Interactive TV Service, Ubiquitous

1. Introduction

Recent interest in ubiquitous digital television broadcast is business model related to interactive and enhanced application running on digital TV platforms. EPG is the core digital television service of which primary function is to provide viewers with overview and schedule information of the current or upcoming television programs(transmitted in broadcast transport streams)[8][9].

The term, Integrated Electronic Service Guide(IESG) refers to the extended concept of the interactive and enhanced application information such as EPG and interactive TV service, mainly within the home, through a standard-based digital TV set-top box.

All terrestrial digital broadcasters adopting Advanced Television System Committee(ATSC) standard[12] have to use Program and System Information Protocol(PSIP)[2] for the EPG service, and Advanced Common Application Platform(ACAP)[3] for the interactive TV service. Cable operators adopting Open-CableTM standard[14] have to use PSIP/SI[15][16] for the EPG service, and Open-CableTM Application Platform Specification(OCAP)[17] for the interactive TV service. Satellite digital broadcasters adopting Digital Video Broadcasting(DVB)[13] have to use Service Information(SI)[18] for the EPG service, and Multimedia Home Platform(MHP)[19] for the interactive TV service. The digital broadcast using ATSC, OpenCableTM and DVB standard follows ISO/IEC 13818-1 MPEG-2 Systems[5] which defines how to transmit encoding standard and other related information to broadcast audio and video. Service Information specification for transmitting program guide is used to generate bit streams of program events such as event name, start and stop time and program rating, based on broadcast service information standard. The generator of service information for program guide has to be compatible with the MPEC-2 encoder systems selected by Digital V(DTV) broadcasters, the multiplexer equipments and broadcast automation. If there's a fault in the service information bit streams, DTV receiver cannot recognize channels or can show misbehaviors when moving to other channels. Therefore, to make the DTV applications work well, first of all, it is mandatory to make sure the bit streams of service information are correct.

ACAP, OCAP and MHP are a standard of data broadcast providing additional services for DTV. These specifications define the standard of contents production which includes images used for transmitting/receiving, data, application API, and also defines the specification for receiver middleware. It also defines how to encode and transmit contents, how to use various Java APIs[3][17][19] to implement service signaling for verification of data transmission/receipt, data encoding, contents production. And the standard also has the specification of interaction channels and data broadcast contents security for interconnecting with Internet

Manuscript received October 5, 2007
Manuscript revised October 20, 2007

provided by ISP(Internet Service Provider). Still there are some unresolved issues for providing EPG service using ATSC PSIP.

First, each terrestrial broadcasters broadcast only their own program guides by using PSIP. Consequently the receiver can only show a specific channel's information when it is tuned to the channel. For a broadcaster to transmit the information of other broadcasters, the broadcaster has to assign bandwidth to do that, however mostly each terrestrial broadcaster doesn't do that for some reasons including physical limit and relationships among broadcasters.

Second, in order to provide categorical genre information, terrestrial broadcasters can carry Directed Channel Change Table(DCCT) and DCC Selection Code Table(DCCSCT) in PSIP. If DCC is not supported by a DTV receiver, there is no visible impact on the main broadcast program perceived by the viewer[2]. These two tables are optional in PSIP. So instead of supporting the tables, broadcasters can use private descriptors in PSIP table, which set-top boxes must implement them.

Third, EPG is a resident application in set-top box for enhanced broadcasting(i.e., without a return channel). The EPG is typically provided by the set-top box manufacturer. Its functionality and look & feel are also determined by the manufacturer[9]. In other words, the EPG processing module is embedded on the receiver, therefore, it is difficult to change GUIs and add more service information, which consequently can limit the services for the viewers. In this paper, the concept of EPG is expanded to IESG, suggesting a methodology that a channel's own program information is received and processed on-air, the information of other channels and the genre information are processed using Return Channel on ATSC in ubiquitous environment. And IESG browsers are implemented as an Xlet-based ACAP application based on data broadcasting specification, which makes the service independent of each STB manufacture's specific EPG, but still meet various service requirements from broadcasters. In the following sections, the outline of Service Information and data broadcasting specification is described and also the actual implementation of IESG developed for the purpose of practical uses.

2. Specification outline for IESG

2.1 PSIP

For the DTV receiver compatible with ATSC specification to receive programs, it has to receive MPEG-2 system standard-based Program Specific Information(PSI)[5] from MPEG-2 transport stream and also receive ATSC Program Information Table. Broadcasters must transmit this kind of information based on the standard, so that DTV receivers including set-top box, TV and PC can receive and decode the information. To make it possible for the digital receiver to show the program guide to viewers, PSIP table is used in the terrestrial broadcast. Receivers use PSI/PSIP[5][2] meta data for the purpose of tuning and demodulation of broadcasting signals, demultiplexing and decoding of digital contents(including video stream, audio stream, data stream, etc) and generation of EPG for easy navigation and selection.

PSIP defines standards of system information and program guide data compatible with the digital multiplex streams following ISO/IEC 13818-1 MPEG-2 System standard[5], and also defines standard protocol to transmit related data tables included in packets of TS. PSIP is a set of tables ordered in a hierarchical way, packeted and multiplexed according to the TS structure described in MPEG-2 System standard

System Time Table(STT) is used for receivers to use the current date and time information. Master Guide Table(MGT) is a list of version, byte size, packet identifier(PID) for all PSIP tables except STT. Virtual Channel Table(VCT) has a list of attributes of virtual channel shipped with Transport stream. VCT table basically includes transport stream ID, channel number, short channel name, carrier frequency, program number, access controlled flag, location field for ETT, service type, etc. Additional information is in descriptor. Rating Region Table(RRT) has the rating information of multiple region for each of which it has the rating system information. Event Information Table(EIT) includes information(title, start time, etc) about events between defined virtual channels. Extended Text Table(ETT) is an optional table including Extended Text Message(ETM) stream. This is used for detailed description of virtual channels or events. Directed Channel Change Table(DCCT) defines virtual channel change requests. DCC Selection Code Table(DCCSCT) caries genre code values, genre criteria name values and state location codes, etc. These two tables are also optional.

2.2 ACAP

For the digital data broadcast receiver compatible with ATSC-ACAP standard[3] to receive the data broadcast successfully, it has to receive Application Information Table(AIT) in digital transmission streams and Object Carousel encoding stream. Broadcasters transmit such data broadcast related contents by using data broadcast system and by following data broadcasting standard. ACAP is a data broadcast standard defined by ATSC, which includes all environments for producing, transmitting and receiving contents. This is a standard of American data broadcasting standard from the collaboration of the terrestrial and cable broadcasters in ATSC North America for the compatibility of digital broadcast contents in each side. ACAP is a data broadcasting standard to enable interactive digital TV

where controlling TV such as changing channels, resizing and moving videos, selecting video/audio is possible, and also transparent or semi-transparent contents service by overlapping the contents on a video program is possible. And synchronization between video program and Java contents, Java contents service in an independent channel are also possible. The terrestrial data broadcasting receiver uses ACAP for the following purposes.

- Interpretation of AIT tables for data broadcast signaling
- Parsing object carousel to interpret received contents
- Implementation of ACAP-J API to interpret contents generated by Java
- Implementation of ACAP-X to interpret contents generated by markup language.
- Implementation of application manager to control application execution schedules
- Implementation of several hardware resources and interface

The structure of ACAP system divides into Java-based ACAP-J and Markup-based ACAP-X. Figure 1 represents ACAP architecture.

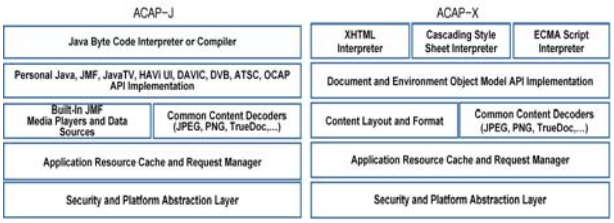


Fig. 1. ACAP architecture

ACAP-J defines APIs to implement data broadcast service using Java and to interpret them in receivers. ACAP-J applications are based on Globally Executable MHP(GEM)[6]. Personal Java is a core API including Personal Java 1.2(JDK 1.1.8) with the security APIs in JDK 1.2. In case of java.awt package, all classes related to display such as Button, TextField were excluded from the standard. Instead HAVi API is provided. This means all heavy weighted components in AWT which were unnecessary for TV environment were excluded. JavaTV API version 1.0 provides access to channel service information, service selection, audio/video media control, access control of data broadcast information, application execution schedule control. As described in javax.tv.xlet, the application execution schedule is controlled by 4 status including Loaded, Paused, Active and Destroyed. JMF(Java Media Framework) version 1.1 is an API to control audio/video streaming data, and also provides video resize functionality using JavaTV API together. DAVIC API version 1.4 is an API enables to control resource assignment and TV A/V specific control. Home Audio Video Interoperability User Interface(HAVi) version 1.0 provides TV-friendly user interface. Applications can use HAVi UI to acquire display information, to control transparency, to deploy text and graphic information and to support remote control such as using color key. JSSE is an API supports secure connection of the interactive service. ACAP standard provides a specific API for a specific media. Such API was redefined by providing service information and specific functionalities. For the terrestrial broadcast, org.dvb, org.davic packages were added, for the cable broadcast, org.ocap, and for contents identification, org.atsc.si package was added.

ACAP uses Object Carousel of Digital Storage Media Command and Control Object Carousel(DSM-CC) for encoding data. Object Carousel expresses service domains consisting of DSM-CC U-U objects on ATSC network. This service domain has a service gateway and is expresses as a graph of service and object name. NSAP(Network Service Access Point) address defined in DSM-CC is used to identify service gateways on the network. Object Carousel of DSM-CC was made for the purpose of transmitting the organized group of objects from a broadcast server to a receiver. Objects include directory objects, file objects and stream objects. Servers use object carousel protocol and insert these objects repeatedly into MPEG-2 TS which meets ATSC standard. The transmitted directory or file objects include the contents of object, but stream objects have only reference to other streams. Stream objects can include DSM-CC events.

Signaling is a protocol used for how receivers can identify related applications, and how to locate them to fetch, how broadcast send signals to control the lifecycle of applications and how receivers can check the source of broadcast data required by a specific service application. AIT provides all information about data broadcast and requires all applications to act as the status delivered to AIT. Based on the data in AIT, broadcasters can send a request to receivers to change the status of applications.

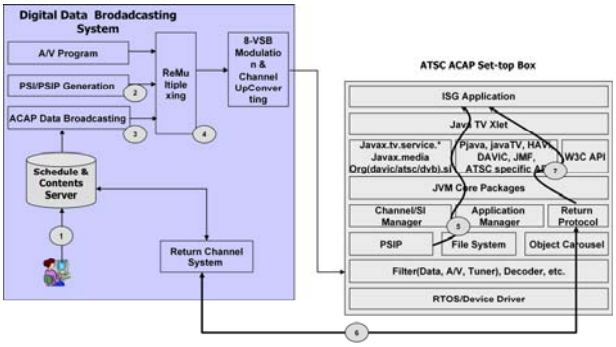
Return path environment is an environment to process interactive services by applications in ACAP receivers. IP, UDP, TCP, HTTP and DNS can be used.

3. IESG System and Service

3.1 System Flow

The system for IESG services divides into two parts. One is to transmit digital program guide and IESG application, the other is to get the program information from IESG screens in STB by the requirements of viewers. A channel's own program guide(PSI and PSIP information) is transmitted by PSIP generator under the control of program guide management server. IESG applications are transmitted from data encoder. When a

set-top box runs IESG, the program guide and genre information are delivered to the receiver via return path. The receiver analyzes the information and show it on its IESG browser. IESG browser can be stored in the receiver in the form of Xlet or embedded. For this paper, however, the browser was designed in Xlet application. Figure 2 shows the flow of IESG system.



Here we summarize some service flow of Figure 2.

① Generating Xlet-based application and scheduling information for IESG
② Transmitting own channel scheduling information
③ Transmitting IESG application
④ Remultiplexing Audio/Video, PSIP, Xlet-based application
⑤ Receiving current own channel information by using JavaT API
⑥ Simultaneously receiving other channel information, genre information, and interactive TV information by return channel
⑦ Displaying IESG

Fig. 2. IESG System flow

3.2 ERD Structure of IESG information for Return Channel

When IESG is implemented, a channel's own program guide is expressed using the receiving PSI/PSIP information. However, the information of other channels are not included in PSIP table. Therefore, that information must be implemented using return path. To get the information of other channels and genre information from the receiver, terrestrial broadcasters need servers with return processing module. The IESG browser in the receiver request the program guides of other channels, the return processing module has to connect to the program guide database and get the information. So, the schedule database must have those information including genre information, data broadcast service information in advance.

Figure 3 shows the database ERD(Entity Relationship Diagram) structure necessary for composing such program guides.

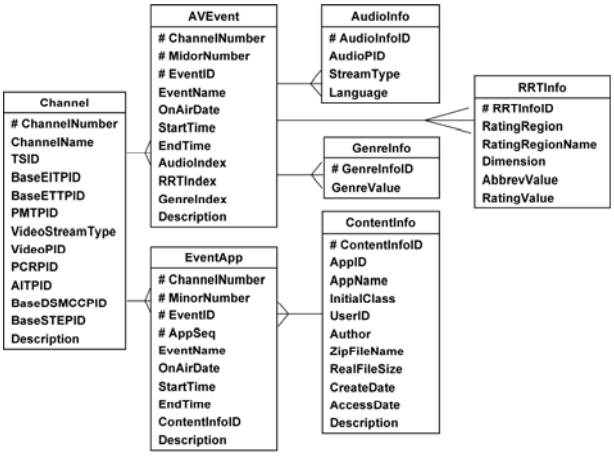


Fig. 3. ERD . Hierarchical structure of IESG information for Return Channel.

The Channel table contains each channel's information. A/V Event table has the program guide for each channel defined in Channel table. Event Application table contains data broadcast guide information for each channel defined in Channel table. Audio Information table defines audio information of each program defined in Channel and A/V Event table. Content Information table has data broadcast service information according to the schedule of each channel defined in Channel table and of data broadcast. Genre Information table defines genre information for each program defined in Channel table and in A/V Event table.

3.3 IESG Application

IESG service implementation using Xlet structure divides into the main class, each menu's classes. Future 4 shows relationship between IESG classes in Xlet structure.

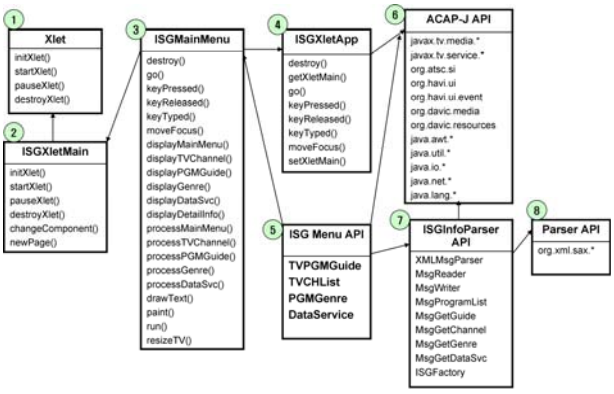


Fig. 4. Relationship between IESG classes.

The main class is implemented using Xlet API defined in JavaTV API and using ISGXletApp API which is the starting class of IESG. The class of each main menu is implemented using ISGMainMenu, ISGXletApp class and IESG menu API. The class analyzing XML[10] message received from return path is implemented using ISGInfoParser API and Parser API. ACAP-J API is an API defined in ACAP-J standard, used for implementation of IESG application.

Figure 5 shows screen shot of IESG Application.

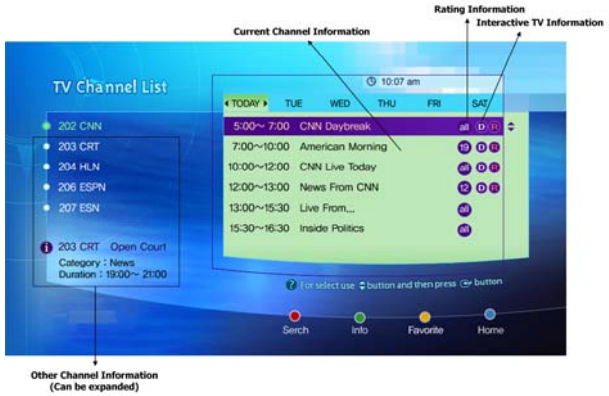


Fig. 5. Screen shot of IESG application. Samsung ACAP Set-top box is used.

4. Conclusions and Future Work

This paper defines extended concept of EPG as IESG, regarding it as a "killer service" to provide not only program guide but also various add-on service information like u-learning. Beyond the concept of embedded native EPG, IESG is a service structure of data broadcast. This concept can be visualized using Xlet application structure defined in ATSC-ACAP and is a basis to enable broadcasters, at any time, to change the contents and GUIs as they want and provide the service. As described in the introduction chapter, this implementation has an advantage to provide genre information for the viewers, which was one of disadvantages in ATSC PSIP. And it can also provide program guide of other channels, which was not possible in the current terrestrial broadcast. This implementation can affect the implementation of home networking. For example, Digital TV is one of the most important home networking devices. If data broadcast using Digital TV adopts the IESG concept introduced in this paper, all other devices inside home also can use IESG service to display information.

The IESG service implemented in this paper is useful for the terrestrial broadcast providers and the receiver manufacturers to get the solution to solve the current problem of EPG service. And, it can be also helpful for the broadcast providers to find new business model using data broadcast. In this trend that combines broadcast with communication, by using TV, an integrated browser of all electric appliances in home can be implemented. The IESG service is compatible with multiple environment and will be an important work for that purpose.

Acknowledgments

The work presented in this paper was funded partially in SEOUL R&BD PROGRAM .

References

[1] ATSC Standard A53C with Amendment No.1 and Corrigendum No.1 : ATSC Digital Television Standard, Rev.C, 2004.
[2] ATSC Standard A/65B: Program and System Information Protocol for Terrestrial Broadcast and Cable, Rev.B, 2003.
[3] ATSC Standard: Advanced Common Application Platform(ACAP), Document A/101, 2 August 2005.
[4] ATSC Standard A/97: Software Download Data Service, 2004.
[5] ISO/IEC 13818-1, “Generic coding of moving pictures and associated audio recommendation H.222.0(systems),” International Organization for Standardization, November 1994.
[6] Digital Video Broadcasting (DVB), Globally Executable MHP version 1.0.1, available as ETSI TS 102 819 V 1.2.1.
[7] ISO/IEC 13818-6, “Information technology-Generic coding of moving pictures and associated audio information: Extensions for Digital Storage Media Command and Control,” 1998.
[8] Chengyuan Peng : Digital Television Applications. University of Technology, Espoo, Finland, November 2002, ISBN 951-22-6172-3.
[9] Chengyuan Peng, Artur Lugmayr, Petri Vuorimaa: A Digital Television Navigator. Multimedia Tools Appl.17(1): 121-141 (2002).
[10] W3C Recommendation, “Extensible Markup Language(XML) 1.0 (Second Edition), » October 2000.
[11] T.Lindholm and F. Yellin, “The Java Virtual Machine Specification Second Edition,” Sun Microsystems, Inc., 2003.