



**Center for Embedded Computer Systems  
University of California, Irvine**

---

## **An Architecture for Home-oriented IPTV Service Platform on Residential Gateway**

<Pyung Soo Kim>

Center for Embedded Computer Systems  
University of California, Irvine  
Irvine, CA 92697-2620, USA

pyungk@uci.edu

CECS Technical Report 12-07  
August 1, 2012

# An Architecture for Home-oriented IPTV Service Platform on Residential Gateway

Pyung Soo Kim<sup>1</sup>

*Center for Embedded Computer Systems  
University of California, Irvine, CA, USA &  
Department of Electronic Engineering  
Korea Polytechnic University, KOREA*

---

## Abstract

In recent, the home network has become a preferred environment for many end-users to receive IP based multimedia services such as Internet Protocol TV (IPTV). In order that end-users in home networks can get opportunities for useful services beyond legacy IPTV services, this technical report suggests a service platform that resides on the residential gateway (RG) for interworking between home network and IPTV. The suggested service platform is called the home-oriented IPTV service platform (HISP) on the RG (HISP-RG). The suggested HISP-RG provides open architecture and functionalities to enable 3<sup>rd</sup> party IPTV service providers to deliver locally and directly home-oriented IPTV services to end-users in home networks. The HISP-RG can be an “add-on” solution of the existing standard RG, that is, not a “built-in” solution. This technical report introduces several home-oriented IPTV services that can be executed and delivered locally through the HISP-RG. Then, the open architecture and functionalities of the HISP-RG are defined and their requirements are specified. Finally, use cases of the HISP-RG are presented for home-oriented IPTV services.

*Key words:* Home Network, IPTV, Service Platform, Open Architecture, Home Electronic System (HES), Home Gateway Initiative (HGI).

---

## 1 Introduction

According to the rapid advancement of broadcasting and telecommunication technology, the Internet Protocol TV (IPTV) has been emerged as new

---

<sup>1</sup> The author is currently working as a visiting research scholar (Invited by Prof. Pai Chou)

promising convergence service and thus are gaining attention from both service providers and end-users [1]-[3]. The challenge for successful deployment of IPTV services is applied not only on the underlying network but also on the service applications and their platforms to adopt new business models toward changing service trends and environments. The IPTV service grows in number of service providers, end-users, and contents enlarging its area of services at the same time. From the future trend in the end-users perspective, the end-user has moved from being a passive audience to being considered as the center of the industry. Thus, the growing quantity of IPTV service results into enormous options for end-users. Under that situation, spotting what the end-user may like or want to enjoy becomes a key factor for victorious IPTV service. Moreover, in addition to legacy IPTV services, user-oriented services such as personalized IPTV service, mobile-oriented IPTV service, home-oriented IPTV service, etc., allow providing more value added services which will make the IPTV service worthwhile. The evolution of IPTV service that adopts more Internet and telecommunication capabilities in step with rapidly developing service environment and new business models requires open, flexible, and agile platform such as personal mobile device, web platform, residential home gateway, etc.

In these days, there can be various types of digital home services in IP-based home network system; data service, multimedia service, entertainment service, security service, home automation service and so on. Among them, multimedia related service is the attractive one to end-user in these home network services. Especially, the home network has become a preferred environment for many end-users to receive IP based multimedia services such as IPTV. That is, IPTV services are likely to be delivered using home networking technology. In order to provide IPTV users with good user experience and to bring down the costs, IPTV devices need to interact seamlessly with the home network and with each other on the home network. For that purpose, the interworking between home network and IPTV service has been researched as shown in [4]-[8].

Meanwhile, in order to encourage the successive growth of IPTV services, it is important to enable 3<sup>rd</sup> party operators to provide various interactive user-oriented IPTV services by making the best use of open architecture and functionalities [9]-[14]. One of the advantages of the 3<sup>rd</sup> party participation in IPTV services is by collecting services from various 3<sup>rd</sup> party and/or retail IPTV service providers who may have different kinds of services, they can offer the more choices to their end-users. In addition, by providing such abundant services over the well known open platform such as personal mobile device, Web platform, residential home gateway, etc., their client does not need to be subjected to the devices which run for designated IPTV service platforms. For the 3<sup>rd</sup> party participation in IPTV services, the IPTV service platform is required, which allows 3<sup>rd</sup> party IPTV service providers to execute and delivery their services to end users. This IPTV service platform resides on

legacy IPTV service provider and support open interfaces in order that 3<sup>rd</sup> party IPTV service providers can participate. However, in existing works [9]-[14], the 3<sup>rd</sup> party participation has been still dependent of the legacy IPTV service operator because they can provide services through only the service platform of the legacy IPTV service provider based on a tariff or contract basis. Thus, the approach in existing works can be a 3<sup>rd</sup> party participation only from the point of legacy IPTV service provider's view. However, from the point of end user's view, this approach might not be a "true" 3<sup>rd</sup> party participation since end users in home can get only services provided by legacy IPTV service providers as well as 3<sup>rd</sup> party IPTV service providers that authorized by legacy IPTV service provider. The OSGi service platform in [15]-[17] can be adopted as an IPTV service platform for the 3<sup>rd</sup> party participation in IPTV services in order that 3<sup>rd</sup> party IPTV service providers to execute and delivery their services to end users. However, in this case, end users in home can get only services bundled by the service aggregator and delivered by the service gateway operator although the OSGi service platform is adopted as an open platform. Therefore, from the point of end user's view, the 3<sup>rd</sup> party participation in IPTV services using the OSGi specifications might not be a true 3<sup>rd</sup> party participation.

Therefore, in home network and IPTV interworked environments, this technical report considers a new approach for the true 3<sup>rd</sup> party participation in IPTV services. This technical report suggests a service platform that allows 3<sup>rd</sup> party IPTV service providers to provide locally and directly diverse home-oriented IPTV services to end users. Through the 3<sup>rd</sup> party participation in IPTV services using the suggested service platform, end users in home should be able to get more and more opportunities for useful services beyond legacy IPTV services from unlimited 3<sup>rd</sup> party IPTV service providers. In addition, 3<sup>rd</sup> party IPTV service providers should be able to provide locally and directly diverse services to end users, while they should be independent from legacy IPTV service providers. Therefore, the suggested service platform should reside on one of home devices such as the residential gateway (RG), legacy IPTV set-top box, desktop PC, etc. Among various home devices, the RG that has been standardized in ISO/IEC Home Electronic System (HES)[18] or Home Gateway Initiative (HGI)[19] can be a beautiful one that the suggested service platform resides on due to following RG's inherent good properties. This means that the RG can work well for the interworking between home network and IPTV as well as the home-oriented IPTV service platform for the 3<sup>rd</sup> party participation in home networks. Therefore, the suggested service platform is called the home-oriented IPTV service platform (HISP) on the RG (HISP-RG). The HISP-RG provides open architecture and functionalities to enable 3<sup>rd</sup> party IPTV service providers to deliver locally home-oriented IPTV services to end-users in home networks. The suggested HISP-RG can be an "add-on" solution of the existing standard RG of ISO/IEC HES or HGI, that is, not a "built-in" solution. This technical report introduces several home-

oriented IPTV services that can be executed and delivered locally through the HISP-RG. In addition, the open architecture and functionalities of the HISP-RG are defined and their requirements are specified. Finally, a couple of use cases of the HISP-RG are presented for home-oriented IPTV services.

The technical report is organized as follows. In Section 2, existing works for the 3<sup>rd</sup> party participation in IPTV services and service platform are discussed. In Section 3, the HISP-RG, is suggested for interworking between home network and IPTV. In Section 4, use cases of the HISP-RG are presented. In Section 5, concluding remarks are made.

## 2 Existing Works for 3<sup>rd</sup> Party Participation in IPTV Services

### 2.1 3<sup>rd</sup> Party Participation in IPTV Services

As IPTV service evolves and augments at the same time, one of the critical issues is the increment of the number of services that can be consumed by end-users. With no limitation of the number of channels or IPTV service companies, not to mention the growing number of IPTV service providers, a rapid increment on the number of services is expected since the end-users can also play the role of service and content producer. Hence, with enormous services, the mechanism or service that serves what an end-user wants gets very important and becomes an essential capability for IPTV service.

With increasing number of the IPTV service providers, a service provider who provides other service provider's IPTV services to end-users, called as a "3<sup>rd</sup> IPTV party service provider", becomes one of the important business domain to enlarge the service coverage in both quantity and quality side. Analysts also agree that the key to differentiation and open innovation of IPTV services are value added services which in the long term require business collaborations of incumbents and 3<sup>rd</sup> party service providers. That is, In order to encourage the successive growth of IPTV services, it is important to enable 3<sup>rd</sup> party operators to provide various interactive user-oriented IPTV services by making the best use of open architecture and functionalities. One of the advantages of 3<sup>rd</sup> party participation in IPTV services is by collecting services from various 3<sup>rd</sup> party and/or retail IPTV service providers who may have different kinds of services, they can offer the more choices to their end-users. In addition, by providing such abundant services over the well known open platform such as personal mobile device, Web platform, residential home gateway, etc., their client does not need to be subjected to the devices which run for designated IPTV service platforms. In other words, their potential clients can be any end-users who have a device with proper applications which is widely and

popularly adopted and used.

ITU-T standardization works [9]-[14] for the 3<sup>rd</sup> party participation in IPTV services are briefly shown. Basically, in the ITU-T recommendation [11], the 3<sup>rd</sup> party application gateway functional block is described to support 3<sup>rd</sup> party application functions that invoke application interfaces to make use of IPTV functionality. The 3<sup>rd</sup> party application gateway functional block provides a controlled interface to enable 3<sup>rd</sup> party application functions to utilize the IPTV related capabilities and resources. The ITU-T recommendation [12] defines functional requirements of the service provider's interface for television primary and secondary distribution and associated interactive services for integrated broadband cable and primary distribution television networks. The service provider's interface for television and associated interactive services is an interface that enables outside entities to offer television and associated interactive services. This interface enables a number of functions such as video delivery management, user information management, and service accounting. Service providers can use these functions through APIs provided by this interface. The ITU-T recommendation [13] describes 3<sup>rd</sup> party IPTV brokering service scenarios and use cases to identify the features on how can it be designed, deployed and operated. The 3<sup>rd</sup> party IPTV brokering service is a service that provides end-users with various services from different service providers. The 3<sup>rd</sup> party IPTV brokering service provider links to diverse service providers and receives their metadata, contents, and/or service access point. Then they aggregate, manage the data to compose as a service and provide the service. By collecting metadata and/or contents from various IPTV service providers who may have different kinds of services, they can offer the more choices to their end-users. In the ITU-T recommendation [14], the flexible IPTV service provider model is taken into consideration to fit with emerging service providers and mobility service providers including mobile TV. The service provider domain is divided into retail service provider (RSP) and IPTV service platform operator sub-domains. RSPs obtain content from content providers and bundle it as a service package. The idea with the RSP model is to set up a platform to implement the functions common to all IPTV service providers, making easier and cheaper the deployment of competing IPTV service providers.

## 2.2 *OSGi Service Platform*

As shown in [9]-[14], the IPTV service platform is required for the 3<sup>rd</sup> party participation in IPTV services, which allows 3<sup>rd</sup> party IPTV service providers to execute and delivery their services to end users. This IPTV service platform resides on legacy IPTV service provider and support open interfaces in order that 3<sup>rd</sup> party IPTV service providers can participate.

In diverse service distributing applications including the IPTV service, a service platform is a necessary entity to support services. As a standard service platform for diverse application areas and markets including home automation, the OSGi service platform has been well known [15]-[17]. The OSGi service platform supports network delivered services for a remote device that can then run locally or in conjunction with other network resources. The OSGi specifications are so widely applicable because it is a small layer that allows multiple, Java<sup>TM</sup> based, components to efficiently cooperate in a single Java Virtual Machine (JVM). In addition, the OSGi specification is explicitly designed to be open and synergistic with a wide range of existing networking and computer technologies and enhances virtually all current networking standards and initiatives. Moreover, the OSGi specification allows service providers to deliver value-added services of their own and selectively allow delivery of services provided by 3<sup>rd</sup> party providers over a variety of networking systems.

The OSGi specifications were initially targeted at residential gateways with home automation applications. However, the attributes of the standard made it applicable, and attractive, to other markets. That is, the OSGi specifications have moved beyond the original focus of service gateways, and are now used in applications ranging from mobile phones to the open source Eclipse. Other application areas include automobiles, industrial automation, building automation, PDAs, grid computing, entertainment, fleet management and application servers. To implement OSGi specifications, the service aggregator is required to bundle services together to build an appealing package and allow multiple 3<sup>rd</sup> party service providers to provide end users with application services in the form of bundles. In addition, the service gateway operator is required for maintaining and managing OSGi service gateways as well as services bundled by the service aggregator. That is, the service gateway operator, which might be Telco or Cable operator, delivers, starts, updates and removes bundled services for end users. This standard technology is called the OSGi Service Aggregation Platform (OSAP). Eventually, multiple 3<sup>rd</sup> party service providers can share the OSGi service gateway through the OSAP, which means they cannot deliver their services locally and directly to end users.

### **3 A Home-Oriented IPTV Service Platform on Residential Gateway**

#### *3.1 Motivation*

As shown in existing works [9]-[14], the 3<sup>rd</sup> party participation in IPTV services is still dependent of the legacy IPTV service operator. That is, 3<sup>rd</sup> party IPTV service providers can provide services through only the service platform of the

legacy IPTV service provider based on a tariff or contract basis. Thus, the approach in existing works can be a 3<sup>rd</sup> party participation only from the point of legacy IPTV service provider's view. However, from the point of end user's view, this approach might not be a "true" 3<sup>rd</sup> party participation since end users in home can get only services provided by 3<sup>rd</sup> party IPTV service providers that authorized by legacy IPTV service provider.

Meanwhile, as shown in [15]-[17], although specifications for the OSGi service platform have targeted diverse application areas and markets, the specification for the IPTV service has not been considered concretely. In addition, as mentioned, the OSAP operated by Telco or Cable operator delivers, starts, updates and removes services bundled by the service aggregator for end users. That is, multiple 3<sup>rd</sup> party service providers can share the OSGi service platform through the OSAP, which means they cannot deliver their services locally and directly to end users. Therefore, in the OSAP, the service gateway operator plays a similar role of the legacy IPTV service provider and the service aggregator plays a similar role of the IPTV brokering service provider and the IPTV service platform operator in the 3<sup>rd</sup> party participation in IPTV services of [13][14]. Of course, the OSGi service platform can be adopted for 3<sup>rd</sup> party participation in IPTV services in order that 3<sup>rd</sup> party IPTV service providers to execute and delivery their services to end users. However, in this case, end users in home can get only services bundled by the service aggregator and delivered by the service gateway operator although the OSGi service platform is adopted as an open platform. Therefore, from the point of end user's view, the 3<sup>rd</sup> party participation in IPTV services using the OSGi specifications might not be a true 3<sup>rd</sup> party participation.

Therefore, in home network and IPTV interworked environments, a new approach is required for the true 3<sup>rd</sup> party participation in IPTV services. This technical report suggests a service platform that allows 3<sup>rd</sup> party IPTV service providers to provide locally and directly diverse home-oriented IPTV services to end users. Through the 3<sup>rd</sup> party participation in IPTV services using the suggested service platform, end users in home should be able to get more and more opportunities for useful services beyond legacy IPTV services from unlimited 3<sup>rd</sup> party IPTV service providers. In addition, 3<sup>rd</sup> party IPTV service providers should be able to provide locally and directly diverse services to end users, while they should be independent from legacy IPTV service providers. Therefore, the suggested service platform should reside on one of home devices such as the residential gateway (RG), legacy IPTV set-top box, desktop PC, etc. Among various home devices, the RG that has been standardized in ISO/IEC Home Electronic System (HES)[18] or Home Gateway Initiative (HGI)[19] can be a beautiful one that the suggested service platform resides on due to following RG's inherent good properties as shown in [18][19]:

- A networking device that connects home network domains to network do-

mains outside the house.

- An always-on, always-connected device.
- A hub device that interconnects all electronic digital home devices to one another device as well as connected to exterior public network.
- An service delivery device that enables service and content providers to deliver services such as entertainment, video and broadband digital streams, monitoring for health care, security and occupancy, home appliance control and preventive maintenance, remote metering, and energy management.

This means that the RG can work well for the interworking between home network and IPTV as well as the home-oriented IPTV service platform for 3<sup>rd</sup> party participation in home networks. Therefore, the suggested service platform is called the home-oriented IPTV service platform (HISP) on the RG (HISP-RG). The HISP-RG provides open architecture and functionalities to enable 3<sup>rd</sup> party IPTV service providers to deliver locally and directly home-oriented IPTV services to end-users in home networks. The HISP-RG is a "add-on" solution of the RG [18][19], that is, not a "built-in" solution.

### 3.2 3<sup>rd</sup> Party Participation for Home-Oriented IPTV Services using HISP-RG

As shown in Fig. 1, the main domains involved in legacy IPTV services are 'End-user', 'Network Provider', 'Service Provider' and 'Content Provider' [11]. The content provider (CP) is the entity that owns or is licensed to sell content or content assets. The service provider (SP) is a general reference to an operator that provides telecommunication services to end-users and other users either on a tariff or contract basis. The network provider (NP) is the organization that maintains and operates the network components required for IPTV functionality. The end-user is the actual user of the products or services.

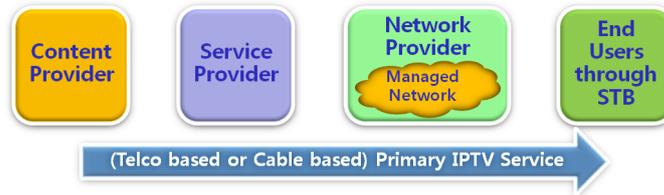


Fig. 1. Main domains for legacy IPTV service

As shown in Fig. 2, the 3<sup>rd</sup> IPTV party service provider can provide end-users with various services through the legacy IPTV service provider using open architecture and functionalities supported by the legacy IPTV service provider [9]-[14].

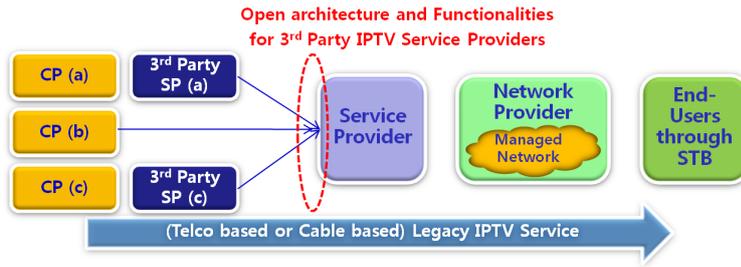


Fig. 2. 3<sup>rd</sup> party participation in legacy IPTV service

In the current technical report, as shown in Fig. 3, both legacy IPTV service and home-oriented IPTV service is provided to end-users in home network through the residential gateway. One of them, home-oriented IPTV services provided by 3<sup>rd</sup> party IPTV service providers are executed and delivered locally and directly to end-users in home networks using the HISP-RG. Therefore, the HISP-RG is required to provide open architecture and functionalities for 3<sup>rd</sup> party IPTV service providers, which will be specified in this document.

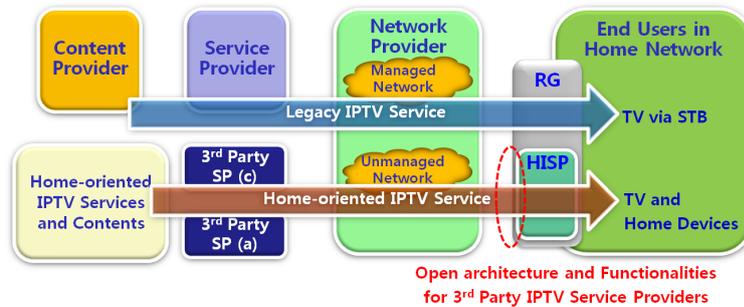


Fig. 3. 3<sup>rd</sup> party participation in HN and IPTV interworking service via HISP-RG

There can be several home-oriented IPTV services that can be executed and delivered locally and directly through the HISP-RG as follows:

- Home Automation & Monitoring Services
- Home Media & Information Services
- Home-oriented Advertising Services
- Home Schooling Services
- Home Healthcare Services
- Smart Grid Services
- Person-to-person Communication Services
- Public Interest Services and Portal Services

### 3.3 Architecture and Functional Requirements of HISP-RG

Fig. 4 shows the architecture and functional diagram of HISP-RG. Functionalities of the HISP-RG are defined and their requirements are specified as

follows.

### *3.3.1 Service Creation*

The HISP-RG is required to implement the service creation function that supports the integrated developing environment including designing, debugging, and testing capabilities for 3<sup>rd</sup> party IPTV service developers' functions to realize home-oriented IPTV services. That is, 3<sup>rd</sup> party IPTV service developers can create easily and rapidly home-oriented IPTV services using programming interfaces provided by this function block.

### *3.3.2 Service Execution & Service Delivery*

As mentioned, various home-oriented IPTV services are executed and delivered via the HISP-RG to provide ultimately values to end-users.:

### *3.3.3 Service & Content Management*

The HISP-RG needs to provide 3<sup>rd</sup> party IPTV service providers as well as developers with necessary architecture and functionalities to manage many aspects of home-oriented IPTV services. Therefore, the HISP-RG is required to implement the service management function that provides necessary capabilities for managing home-oriented IPTV services for 3<sup>rd</sup> party IPTV service providers as well as developers. In addition, the HISP-RG is also required to implement the content management function. The content management function enables content transmission between service providers, content storage management, video and audio transcoding with format conversion. When a 3<sup>rd</sup> party IPTV service provider specifies format change for their home-oriented IPTV content, this function enables format conversion and storage of the modified content, such as video resolution, frame rate, progressive or interlaced, the number of audio channels, sampling frequency, the number of bits for quantization, video/audio codec type and bit rate. These format change functions enable 3<sup>rd</sup> party IPTV service providers to provide their home-oriented IPTV services to multiple types of user clients that have different capabilities.

### *3.3.4 Service Provider Management*

The HISP-RG is required to implement the 3<sup>rd</sup> party IPTV service provider management function such as issuing and managing login accounts for 3<sup>rd</sup> party IPTV service providers. Login account is used to authenticate a service provider to ensure that only authorized service providers can access the HISP-RG.

### *3.3.5 Home Network and Home Devices Management*

A large number of home devices connected together by the HISP-RG in home network can be managed by 3<sup>rd</sup> party IPTV service providers, and these home devices may need to be managed remotely. Thus, it is very important for 3<sup>rd</sup> party IPTV service providers to have a standardized way to remotely manage numerous home devices and provide home-oriented IPTV services in an efficient and economical way. Therefore, the HISP-RG is required to implement the home network management function to utilize capabilities and functions of numerous home network devices, to remotely manage them, to provide home-oriented IPTV services for them. Especially, the home network management function might play an important role for home-oriented IPTV services such as home automation & monitoring services, home-oriented advertising services, home healthcare services, and smart grid services.

### *3.3.6 Remote Platform Management*

The HISP-RG is required to implement the remote platform management function in order to support maintenance, trouble shooting and control of the HISP-RG for 3<sup>rd</sup> party IPTV service providers. In addition, configuration, fault, performance management and firmware upgrades can be also supported. Using this function, the administrator such as Telco or Cable operators can remotely manage the HISP-RG.

### *3.3.7 End-user Profile Management*

The HISP-RG is required to implement the end-user profile management function to store and manage end-user information such as user profile, price plan, parental lock level, service charge information, etc. This end-user information is stored for each service provider and a service provider cannot access the user information owned by other service providers. In addition, the HISP-RG is required to implement the accounting function that enables service providers to charge service fees to user clients. When the service provider charges a new service fee for the user, this interface is required to obtain the user's permission first. Moreover, the HISP-RG is required to implement the report function, which provides the fulfilment data related to services. For this purpose, this interface enables aggregation of the activity information from end-users the data to 3<sup>rd</sup> party IPTV service providers. The report information includes statistics regarding audiences, e.g., audience measurement information, service fulfilment measurement, interactive application fulfillment, other information regarding end-user behavior. Finally, the HISP-RG is required to perform authentication between 3<sup>rd</sup> party IPTV service providers and end-users. In order to provide better support for the HISP, a local management function may be

needed to complement the remote platform management. The local management function is the access method the end-user uses to view or make changes to HISP configuration, end-user managed services, end-user managed devices and other safe settings.

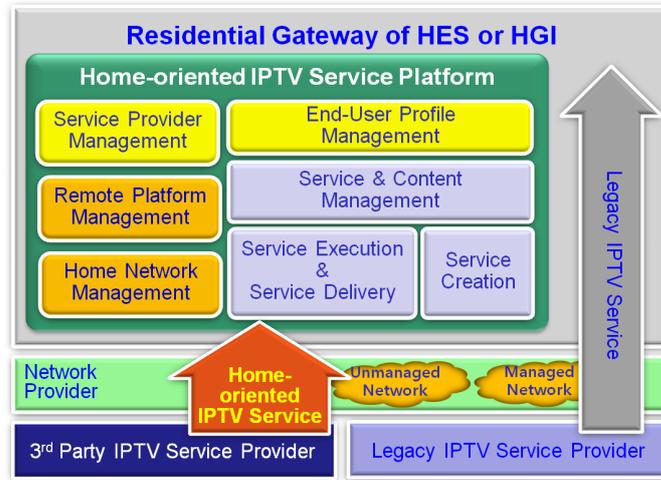


Fig. 4. Architecture and functional diagram of HISP-RG

## 4 Use Cases

In this section, a couple of use cases of the HISP-RG are introduced for home-oriented IPTV services.

### 4.1 Consumer Advertising or Retail Advertising Service

The HISP-RG can recognize that laundry detergent or washing powder is exhausting and notify this event to the 3<sup>rd</sup> party service provider. Then, the 3<sup>rd</sup> party IPTV service provider delivers a commercial advertising about laundry detergent or washing powder to end users through HISP-RG. Ultimately, end users can watch a commercial advertising on their TV screen as shown in Fig. 5.

### 4.2 Healthcare or Medical Service

The HISP-RG can recognize end user's biological information using sensors in home network and inform this event to the 3<sup>rd</sup> party IPTV service provider. Then, the 3<sup>rd</sup> party IPTV service provider delivers a healthcare video according to end user's blood pressure status to end users through HISP-RG.

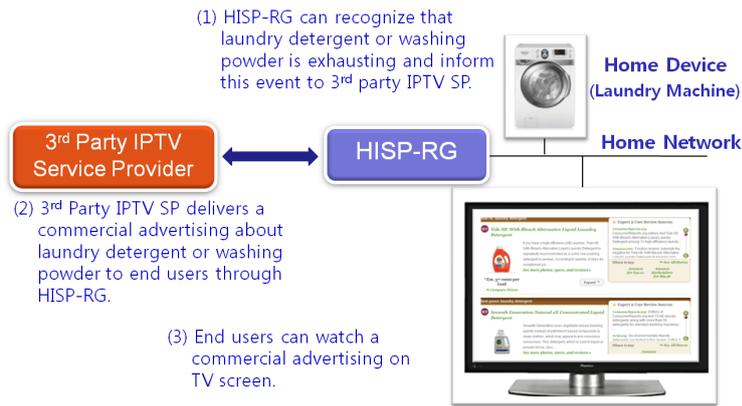


Fig. 5. Use case for consumer advertising or retail advertising service

Ultimately, end users can watch a healthcare video on their TV screen as shown in Fig. 6.

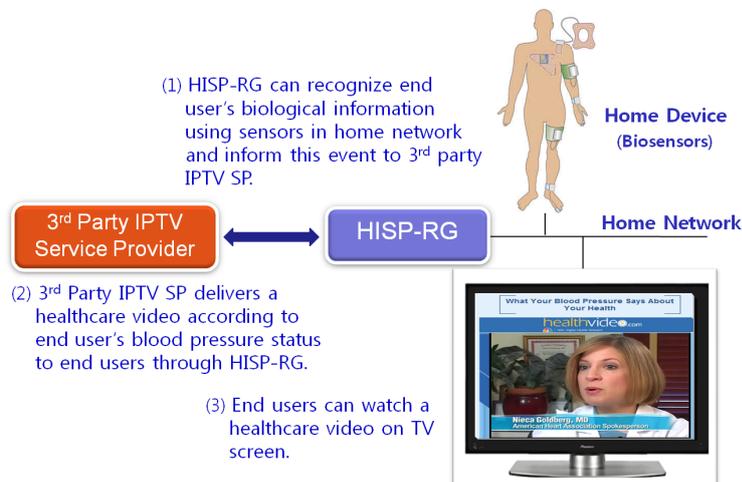


Fig. 6. Use case for healthcare or medical service

## 5 Concluding Remarks

This technical report has suggested a service platform that resides on the RG for interworking between home network and IPTV in order that end-users in home networks can get opportunities for useful services beyond legacy IPTV services. The suggested service platform has been called the home-oriented IPTV service platform on the RG (HISP-RG). The suggested HISP-RG has provided open architecture and functionalities to enable 3<sup>rd</sup> party IPTV service providers to deliver locally and directly home-oriented IPTV services to end-users in home networks. The HISP-RG can be an "add-on" solution of the existing RG of ISO/IEC HES or HGI, that is, not a "built-in" solution. This technical report has introduced several home-oriented IPTV

services that can be executed and delivered locally through the HISP-RG. Then, the open architecture and functionalities of the HISP-RG have been defined and their requirements are specified. Finally, a couple of use cases of the HISP-RG have been presented for home-oriented IPTV services.

## References

- [1] S. V. Vasudevan, L. Xiaomei, K. Kollmansberger, IPTV systems, standards and architectures: Part II - IPTV architectures for cable systems: An evolutionary approach, *IEEE Communications Magazine* 46 (5) (2008) 102–109.
- [2] J. Maisonneuve, M. Deschanel, J. Heiles, W. Li, H. Liu, R. Sharpe, Y. Wu, An overview of IPTV standards development, *IEEE Transactions on Broadcasting* 55 (2) (2009) 315–328.
- [3] S. Park, S.-H. Jeong, Mobile IPTV: approaches, challenges, standards and QoS support, *IEEE Internet Computing* 13 (3) (2009) 23–31.
- [4] H.622.1, Architecture and functional requirements for home networks supporting IPTV services, ITU-T Recommendation, 2008.
- [5] E. Shiharb, L. Cai, F. Wan, A. Gulliver, N. Tin, Wireless mesh networks for in-home iptv distribution, *IEEE Network : The Magazine of Global Internetworking* 22 (1) (2008) 52–57.
- [6] C. Mingardi, M. Brunner, IPTV quality of service management in home networks, in: *Proc. of IEEE International Conference on Communications (ICC'09)*, 2009, pp. 1–5.
- [7] J. S. Wey, J. Luken, J. Heiles, Standardization activities for iptv set-top box remote management, *IEEE Internet Computing* 13 (3) (2009) 32–39.
- [8] A. Ramirez-Acosta, M. Garcia-Vazquez, IPTV technology and its distribution in home networks, in: *Proc. of Electronics, Robotics and Automotive Mechanics Conference (CERMA)*, 2010, pp. 287–291.
- [9] M. Korling, Evolution of open IPTV standards and services, in: *Proc. of the 1st ITU-T Kaleidoscope Academic Conference Innovations in NGN: Future Network and Services (K-INGN)*, 2008, pp. 11–14.
- [10] J. Yang, H. Park, J. Choi, A study on providing Open IPTV in next generation network service platform, in: *Proc. of the 9th International Symposium on Communications and Information Technology (ISCIT)*, 2009, pp. 290–293.
- [11] Y.1910, IPTV functional architecture, ITU-T Recommendation, 2008.
- [12] J.704, Functional requirements of the service provider interface for television primary and secondary distribution and associated interactive services, ITU-T Recommendation, 2008.

- [13] Y.IPTVBrokeringScenario, IPTV brokering service scenario, ITU-T Q.8/13 Recommendation, 2009.
- [14] HSTP.IPTV-ISPF, IPTV service platform, ITU-T Q.13/16 Recommendation, 2009.
- [15] O. Alliance, OSGi Release 4.3, <http://www.osgi.org>, 2011.
- [16] H. W. Bitzer, Service aggregation for the networked home, in: Proc. of OSGi World Congress, 2002, pp. 1–5.
- [17] R. Kawamura, H. Maeomichi, I. Yamasaki, K. Mori, Standardization trends of osgi technology, NTT Technical Review 6 (1) (2008) 1–7.
- [18] I. 15045-1, Information technology - Home electronic system - Gateway - Part 1: A residential gateway model for HES, ISO, 2004.
- [19] H. G. Initiative, Home Gateway Technical Requirements: Release 1.0, <http://www.homegatewayinitiative.org>, 2006.