An Architecture for Home-Oriented IPTV Service Platform on Residential Gateway

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Abstract—In order for end-users in home networks to receive opportunities for useful services that go beyond legacy Internet Protocol TV (IPTV) services, this paper proposes a service platform that resides on the residential gateway (RG) for interworking between the home network and IPTV. This proposed service platform is called the home-oriented IPTV service platform (HISP) on the RG (HISP-RG). The proposed HISP-RG provides open architecture and functionalities to enable 3rd party IPTV service providers to locally and directly deliver home-oriented IPTV services to end-users in home networks. The HISP-RG can be an “add-on” and not a “built-in” solution for the existing standard RG. This paper 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 for home-oriented IPTV services are presented.

Keywords—A Home Network, IPTV, Service Platform, Open Architecture, Home Electronic System (HES), Home Gateway Initiative (HGI)

1. INTRODUCTION

Currently, 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 the home network and the IPTV service has been researched as shown in [1]-[5].

Meanwhile, in order to encourage the successive growth of IPTV services, it is important to enable 3rd party operators to provide various interactive user-oriented IPTV services by making the best use of open architecture and functionalities [6]-[11]. One of the advantages of having 3rd party participation in IPTV services is that by collecting services from various 3rd party and/or retail IPTV service providers who may provide different kinds of services and offer more choices to their end-users. In addition, by providing such abundant services over a 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 that run on designated IPTV service platforms. For 3rd party participation in IPTV services, an IPTV service platform, which allows 3rd party IPTV service providers to execute and deliver their services to end users, is required. This IPTV service platform resides on a legacy IPTV service provider and supports open interfaces in order...
that 3rd party IPTV service providers can participate. However, in existing works [6]-[11], 3rd party participation has still been dependent of the legacy IPTV service operator because they can provide services only through 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 3rd party participation only from the legacy IPTV service provider’s point of view. However, from the end user’s point of view, this approach might not be a “true” 3rd party participation since home end users can only get services provided by legacy IPTV service providers, as well as 3rd party IPTV service providers that are authorized by the legacy IPTV service provider. The OSGi service platform in [12]-[14] can be adopted as an IPTV service platform for the 3rd party participation in IPTV services in order that 3rd party IPTV service providers execute and deliver their services to end users. However, in this case, home end users can get only services bundled by the service aggregator and they can only be delivered by the service gateway operator, even though the OSGi service platform is adopted as an open platform. Therefore, from the end user’s point of view, 3rd party participation in IPTV services using the OSGi specifications might not be true 3rd party participation.

Therefore, for home network and IPTV interworked environments, this paper considers a new approach for true 3rd party participation in IPTV services. This paper proposes a service platform that allows 3rd party IPTV service providers to locally and directly provide diverse home-oriented IPTV services to end users. Through 3rd party participation in IPTV services using the proposed service platform, home end users should be able to get more and more opportunities for useful services, which go beyond legacy IPTV services, from unlimited 3rd party IPTV service providers. In addition, 3rd party IPTV service providers should be able to locally and directly provide diverse services to end users, while being able to remain independent from legacy IPTV service providers. Therefore, the proposed service platform should reside on one of the home devices such as the residential gateway (RG), legacy IPTV set-top box, desktop PC, etc. From among all of the various home devices, the RG that has been standardized in the ISO/IEC Home Electronic System (HES)[15] or the Home Gateway Initiative (HGI)[16] can be a beautiful one that the proposed service platform resides on due to the RG’s inherent good properties as shown in [15][16]. This means that the RG can work well for the interworking between the home network and IPTV, as well as for the home-oriented IPTV service platform for 3rd party participation in home networks. Therefore, the proposed 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 3rd party IPTV service providers to locally deliver home-oriented IPTV services to end-users via home networks. The proposed HISP-RG can be an “add-on” and not a “built-in” solution for the existing standard RG of ISO/IEC HES or HGI. This paper introduces several home-oriented IPTV services that can be locally executed and delivered 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.

2. RELATED WORKS AND MOTIVATION

2.1 3rd Party Participation in IPTV Services

ITU-T standardization works [6]-[11] for the 3rd party participation in IPTV services are brief-
ly shown as follows. Basically, in the ITU-T recommendation [8], the 3rd party application gateway functional block is described to support 3rd party application functions that invoke application interfaces to make use of IPTV functionality. The 3rd party application gateway functional block provides a controlled interface to enable 3rd party application functions to utilize the IPTV related capabilities and resources. The ITU-T recommendation [9] defines functional requirements of the service provider’s interface for the primary and secondary distribution of television and for the 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. The ITU-T recommendation [10] describes a 3rd party IPTV brokering service that provides end-users with various services from different service providers. The 3rd 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. In the ITU-T recommendation [11], 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 that are common to all IPTV service providers, making the deployment of competing IPTV service providers easier and cheaper.

2.2 OSGi Service Platform

As shown in [6]-[11], the IPTV service platform is required for there to be 3rd party participation in IPTV services. The IPTV service platform allows 3rd party IPTV service providers to execute and deliver their services to end-users. This IPTV service platform resides on the legacy IPTV service provider and supports open interfaces in order for 3rd party IPTV service providers to be able to 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 is well known [12]-[14]. 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 were initially targeted at residential gateways with home automation applications. Since then, 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. To implement OSGi specifications, the service aggregator is required to bundle services together to build an appealing package and to allow multiple 3rd 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 for services bundled by the service aggregator. That is, the service gateway operator, which might be a 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). Ultimately, multiple 3rd 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.
2.3 Motivation

As shown in existing works [6]-[11], 3rd party participation in IPTV services is still dependent on the legacy IPTV service operator. That is, 3rd party IPTV service providers can provide services only through the service platform of the legacy IPTV service provider based on a tariff or contract basis. Thus, the approach in existing works can only be a 3rd party participation from the legacy IPTV service provider’s point of view. However, from the end user’s point of view, this approach might not be a “true” 3rd party participation since home end users can only get services provided by 3rd party IPTV service providers that are authorized by the legacy IPTV service provider.

Meanwhile, as shown in [12]-[14], although specifications for the OSGi service platform have targeted diverse application areas and markets, the specification for the IPTV service has not been concretely considered. In addition, the OSAP operated by a Telco or Cable operator delivers, starts, updates, and removes services bundled by the service aggregator for end users. That is, multiple 3rd 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 as the legacy IPTV service provider and the service aggregator plays a similar role as the IPTV brokering service provider and as the IPTV service platform operator in the 3rd party participation in IPTV services of [10][11]. Of course, the OSGi service platform can be adopted for 3rd party participation in IPTV services in order for 3rd party IPTV service providers to be able to execute and deliver their services to end users. However, in this case, home end users can get only services bundled by the service aggregator and delivered by the service gateway operator, even though the OSGi service platform has been adopted as an open platform. Therefore, from the end user’s point of view, the 3rd party participation in IPTV services using the OSGi specifications might not be a true 3rd party participation. As such, in home network and IPTV interworked environments, a new approach is required for the true 3rd party participation in IPTV services.

3. A HOME-ORIENTED IPTV SERVICE PLATFORM ON A RESIDENTIAL GATEWAY

3.1 3rd Party Participation for Home-Oriented IPTV Services using HISP-RG

In this section, a service platform is proposed to allow 3rd party IPTV service providers to locally and directly provide diverse home-oriented IPTV services to end users. Through 3rd party participation in IPTV services using the proposed service platform, home end users should be able to get more and more opportunities for useful services beyond legacy IPTV services from unlimited 3rd party IPTV service providers. In addition, 3rd party IPTV service providers should be able to locally and directly provide diverse services to end users, and they should be able to be independent of legacy IPTV service providers. Therefore, the proposed service platform should reside on a home device, such as the residential gateway (RG), legacy IPTV set-top box, desktop PC, etc. From among all of the various home devices, the RG that has been standardized in the ISO/IEC Home Electronic System (HES)[15] or the Home Gateway Initiative (HGI)[16] can be a beautiful one that the proposed service platform resides on due to the RG’s inherent good properties as follows:
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- A networking device that connects home network domains to network domains outside the house.
- An always-on, always-connected device.
- A hub device that interconnects all electronic digital home devices to one another, as well as being connected to an exterior public network.
- A 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 controls and preventive maintenance, remote metering, and energy management.

This means that the RG can work well for the interworking between the home network and IPTV, as well as for the home-oriented IPTV service platform for 3rd party participation in home networks. Therefore, the proposed 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 3rd party IPTV service providers to locally deliver home-oriented IPTV services to end-users via home networks. The proposed HISP-RG for the RG [15][16] is an “add-on” and not a “built-in” solution.

As shown in Fig. 1, the 3rd IPTV party service provider can provide end-users with various services through the legacy IPTV service provider by using the open architecture and functionalities that are supported by the legacy IPTV service provider [6]-[11]. In this paper, as shown in Fig. 2, both legacy IPTV service and home-oriented IPTV service is provided to end-users in the home network through the residential gateway. The home-oriented IPTV services provided by 3rd party IPTV service providers are executed and delivered locally and directly to end-users in

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**Fig. 1. 3rd party participation in legacy IPTV service**

**Fig. 2. 3rd party participation in HN and IPTV interworking service via HISP-RG**

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home networks by using the HISP-RG. Therefore, the HISP-RG is required to provide open architecture and functionalities for 3rd party IPTV service providers. All of which will be specified in this paper. There can be several home-oriented IPTV services that can be locally and directly executed and delivered 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

3.2 Architecture and Functional Requirements of the HISP-RG

Fig. 3 shows the architecture and functional diagram of the HISP-RG. The functionalities of the HISP-RG are defined and their requirements are specified as listed below.

☐ **Service Creation**

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

☐ **Service Execution & Service Delivery**

As mentioned before, various home-oriented IPTV services are executed and delivered via the HISP-RG to ultimately provide values to end-users.
• **Service & Content Management**

The HISP-RG needs to provide 3rd party IPTV service providers, as well as developers, with the 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 the necessary capabilities for managing home-oriented IPTV services for 3rd party IPTV service providers, as well as for 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, and video and audio transcoding with format conversion. When a 3rd party IPTV service provider specifies a format change for their home-oriented IPTV content, this function enables format conversion and storage of the modified content. Examples of formation include 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 3rd party IPTV service providers to provide their home-oriented IPTV services to multiple types of user clients that have different capabilities.

• **Service Provider Management**

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

• **Home Network and Home Device Management**

3rd party IPTV service providers can manage a large number of home devices that are connected together by the HISP-RG on a home network, and these home devices may need to be managed remotely. Thus, it is very important for 3rd party IPTV service providers to have a standardized way to remotely manage numerous home devices and to provide home-oriented IPTV services in an efficient and economical way. As such, the HISP-RG is required to implement the home network management function to utilize the capabilities and functions of numerous home network devices, to remotely manage them, and 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 and monitoring services, home-oriented advertising services, home healthcare services, and smart grid services.

• **Remote Platform Management**

The HISP-RG is required to implement a remote platform management function in order to support maintenance, troubleshoot, and control the HISP-RG for 3rd party IPTV service providers. Configuration, fault, performance management, and firmware upgrades can be also supported. Using this function, the administrator, such as a Telco or Cable operators, can remotely manage the HISP-RG.

• **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 the user profile, price plan, parental lock level, service charge information, etc. This end-user information is stored for each service provider and a ser-
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 fulfillment data that is related to services. For this purpose, this interface enables the aggregation of the activity information from the end-users data to 3rd party IPTV service providers. The report information includes statistics regarding audiences (e.g., audience measurement information, service fulfillment measurement, and interactive application fulfillment) and other information regarding end-user behavior. Finally, the HISP-RG is required to perform authentication between 3rd 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 that the end-user uses to view or make changes to HISP configuration, end-user managed services, end-user managed devices, and other safe settings.

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 that the washing powder is almost out and can notify a 3rd party service provider about this. Then, the 3rd party IPTV service provider delivers a commercial advertisement about laundry detergent or washing powder to end users through HISP-RG. Ultimately, end users can watch a commercial on their TV screen as shown in Fig. 4.

![Fig. 4. Use case for consumer advertising or retail advertising service](image-url)
4.2 Healthcare or Medical Services

The HISP-RG can recognize end user’s biological information using sensors in the home network and can inform a 3rd party IPTV service provider of these things. Then, the 3rd party IPTV service provider delivers a healthcare video according to the end user’s blood pressure status to the end user(s) through HISP-RG. Ultimately, end users can watch a healthcare video on their TV screen as shown in Fig. 5.

5. CONCLUSION

This paper has proposed a service platform that resides on the RG for interworking between the home network and IPTV, in order that end-users in home networks can receive opportunities for useful services that go beyond legacy IPTV services. The proposed service platform has been called the home-oriented IPTV service platform on the RG (HISP-RG). The proposed HISP-RG has provided open architecture and functionalities to enable 3rd party IPTV service providers locally and directly to deliver home-oriented IPTV services to end-users in home networks. The HISP-RG can be an “add-on” and not a “built-in” solution for the existing RG of ISO/IEC HES or HGI. This paper has introduced several home-oriented IPTV services that can be executed and delivered locally through the HISP-RG. The open architecture and functionalities of the HISP-RG have been defined and their requirements have been specified. Finally, a couple of use cases of the HISP-RG were presented for home-oriented IPTV services.
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