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The integration of home-automation and IPTV system and services

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ABSTRACT

In this paper we propose the integration of a home-automation system and its services (HASS) with an IPTV system and its services (IPTVSS) to enable convergence at the network-technology and user-interface levels. The convergence at the network-technology level was achieved by using the Internet protocol (IP), and therefore both integrated systems have to provide IP connectivity. To enable communication between the HASS and the IP-based services, we have implemented the WebService/Konnex gateway. The IPTVSS are IP based; therefore, an easy convergence at the network-technology level is possible. The convergence at the user-interface level was achieved by a hardware and software user-interface implementation.

1. Introduction

With the advent of the digital era, the role of data-broadcasting systems and services, such as the IPTV system and its services (IPTVSS), in providing users with value-added information via their TV sets has become important. Meanwhile, home-networking systems and services, such as the home-automation system and its services (HASS), which control heterogeneous devices, are now in the spotlight [1]. The theory of integrating various systems and services opens the door wide to a number of discussions on new, converged network services [2], which is why in this paper we present an implementation of HASS and IPTVSS integration.

With the development of low-cost electronic elements, HASS is gradually migrating from the company sector to the consumer market. Market research has shown that most future living environments will be equipped with this type of system and services [2]. There are a number of systems currently available on the market that can automate various processes, e.g., heating, ventilating and air-conditioning systems, using different communications standards; the most frequently used of which are Konnex [3], LonWorks [4], X-10 [5] and BAC net [6]. Our study is based on the Konnex standard, which, in our opinion, is the best, because of its flexibility and advanced services; it is also the most commonly used such system in Europe. HASS also provides Internet connectivity, thereby enabling users to remotely control their HASS applications using home-automation servers. These home-automation servers have a variety of user interfaces; however, these interfaces are usually proprietary, and thus program intervention at the user interface is either impossible or very limited.

Generally speaking, the term IPTV refers to a system whereby digital television services are delivered to the home using the Internet protocol over a suitable underlying network infrastructure. Today, IPTVSS technologies and the available broadband bandwidths have now evolved to the point where broadband access providers can effectively enter the market for delivering TV programs to their customers [7]. In the broader sense, IPTV comprises the following: (1) the live IPTV video service (live television), which represents one of the most common IPTV services; (2) the video-on-demand service (VoD), which allows users to listen to audio or view video content when they want; (3) the personal video-recording service (PVR), which allows users to record and timeshift their video content; and (4) the electronic program-guide service (EPG), which offers additional content information and can be used to trigger the IPTV, VOD and PVR services.

Although both the IP and Konnex networks are based on the OSI reference model, the technologies involved are not the same because different physical media and communication protocols are used. Furthermore, various, and mostly non-uniform, user interfaces for different devices are used, which can be confusing for the user. In general, user interfaces can be divided into two distinct groups: hardware user-interfaces and software user-interfaces. HASS mostly uses personal computers with a mouse, a keyboard and a display as the hardware user-interface and the control program application with a graphical user interface as the software user-interface. On the other hand, the IPTVSS hardware user-interface generally consists of a set-top box with a remote controller connected to the TV set. The IPTVSS software user-interface is usually web based and specifically designed for the TV environment. The set-top box works as a client, enabling

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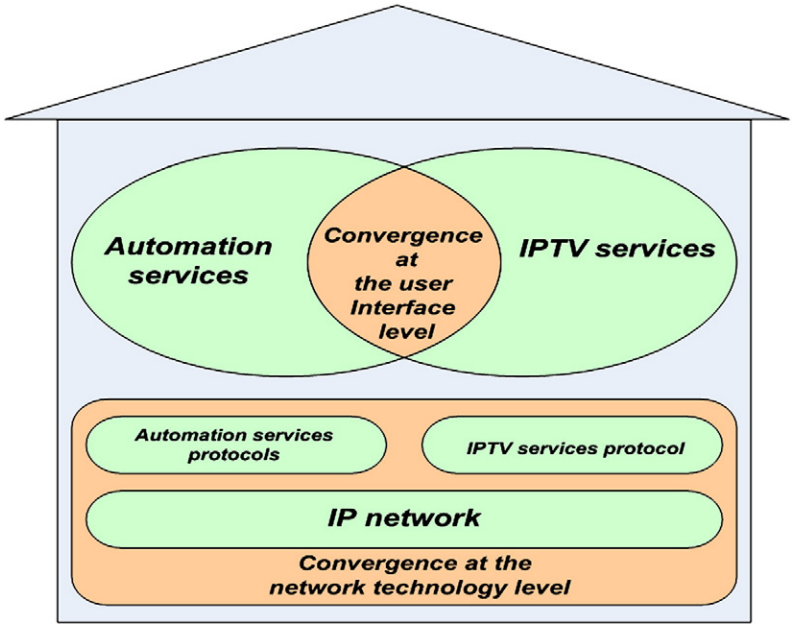

Fig. 1. HASS and IPTVSS integration.

content streaming from the IPTV system, where the complete program application with a graphical user interface is installed.

Since HASS and IPTVSS use different network technologies and user interfaces, we propose and have implemented an integrated system that allows convergence at the network-technology level, based on the IP network, and convergence at the user-interface level, providing common services, as shown in Fig. 1. The user interface of the implemented system consists of a common hardware and software user-interface.

2. Related work

To fulfill the requirements for convergence at the IP network-technology level, HASS and IPTVSS have to provide IP connectivity. IPTVSS is already based on the IP standard and thus is ready for convergence at the network-technology level. Since HASS is not IP-based we first reviewed the related works focused on HASS and IP-based network integration. In order to integrate these two completely different systems, i.e., HASS and IPTVSS, and to provide convergence at the user-interface level, we also studied the related works enabling these requirements.

2.1. IP network technology convergence

In the IP-based environment the Simple Network Management Protocol (SNMP) [8] can be used to control and monitor different HASS devices. However, this approach requires additional processing and can have a negative effect on the overall performance. Another approach, discussed in Ref. [9], suggests that Java-based applications could be used to access the Konnex network, which provides all the benefits of the Java-based platform, most notably hardware independence. However, a Java virtual machine requires high-performance hardware. The approach described in Ref. [10] involves the integration of HASS and IP-based networks using the OSGi service framework, defined in the OSGi specification [11], and which is also Java based. In addition to all the advantages and disadvantages of the Java platform, practical experience with OSGi has shown that service interoperability becomes very complex as soon as an unknown configuration of services in the target environment is considered. Another possible obstacle to using OSGi is the relatively high license fees being charged. The OPC [12] specification is another viable solution. However, a study [13] has shown that OPC interfaces increase security risks in web-based applications and do not allow access to OPC servers from non-Windows devices. To overcome this problem a middleware framework for combining OPC and Web Services was proposed. However, in addition to the high price of the hardware providing the OPC functionality, this approach requires more high-performance hardware providing Web Service functionality, which additionally increases the complexity of the installation. Similarly, approach [14] uses a LonWorks HASS to communicate with the remote server using a Web Services technology.

After considering all the benefits and drawbacks of the above-mentioned approaches we decided to use Web Services technology to communicate between the Konnex and IP-based networks using a single device called the WebService/Konnex gateway.

2.2. User-interface convergence

In Ref. [15] authors discuss the transmission of digital MPEG-4 video over the OSGi framework. Their evaluation of a prototype showed that the most critical factor is the encoding time, which results in the use of effective hardware encoders that are usually inappropriate for use in an IPTVSS. An additional problem is that OSGi is not a suitable middleware solution for IPTV. Interactive digital TV (IDTV) and OSGi integration issues were also addressed in Refs. [16–18], with the focus on different IDTV middleware platforms, such as the MHP (Multimedia home platform), the ACAP (Advanced common application platform), the OCAP (Open cable application platform) and the DASE (Digital TV application software environment). The principles involved in these approaches are interesting, but a serious implementation example is lacking. That is why another similar improved solutions enabling the integration of the MHP IDTV middleware and the OSGi framework has been realized [19,20], enabling collaboration between the OSGi platform, installed on a Residential Gateway, and the MHP, installed in a set-top box. In general, set-top boxes are not just the decoders for a digital television broadcast; they are also suitable platforms for supporting the execution of interactive applications. These approaches enable the control and monitoring of multimedia and home-automation services using a TV set and a remote control, and as a result convergence at the user-interface level is achieved. A potential problem with the MHP approach is that the MHP is Java based and as such requires a higher level of hardware performance from the set-top boxes, which imposes additional costs and so might be unacceptable to service providers.