The Study of Home Appliances Remote Control Based on OSGi

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Abstract-*In this paper the applications of home networking technologies and discussion about the trend of home network are introduced. A home appliances remote control system based on OSGi [1] and LonWorks [2] technology has been presented. Users can query the appliances status and control them remotely through the user interface that appearing in web pages.*

Keywords: Home Network, OSGi, LonWorks, LonTalk.

1. Introduction

With the development of technology, there are more and more new home networking technologies have been presented. A lot of intelligent appliances are appearing in the home environment. Those intelligent appliances which provide by different equipment vendor make the structure of home networking more complicated. The integration of home networking technologies has become an important research.

For a long time, network has been regarded as a technology which to allow users to share internet connection, or printer. Today, there are more and more electrical home appliances and devices support the network connection ability. Roughly say, intelligent home networking means the devices or appliances systems in the home area or living environment which can be controlled, monitored or can offer ability of stream transmission via network. Home network technology makes people's life have very great improvement, makes the environment at home more convenient, safer and more efficient.

The applications of home networking technologies may be classified into following fields [3]:

Home automation – It provides a centralized point for automation of home environment. Home networking technologies can help human to create a more confident living environment.

Home entertainment – This application take advantage of A/V content feeds from the service provider in the internet or A/V disk storage in the home area.

Network communication – The home networking technologies provide network communication ability to each home appliance.

Security service – It can provide household status monitor service. Home user can monitor and control security service utilizing web user interface.

Medical care - The remote monitor and control advantages of home networking technologies provide the home patients well medical care system.

The general households usually adopt different technologies and equipments to construct home network. The construction and application have caused a lot of questions. How to operate numerous standards and equipments simultaneously and offer convenient house environment for mankind are become the hottest topics now.

2. Network Technologies Applied in Home

2.1. Home Networking Structure

The following figure shows the home networking structure. Generally, the home networking structure may be separate into two categories: WAN and home area. Operate over the WAN are the well known network technologies. In the home area, there are a lot of standards and technologies working and providing services. The home area appliances connect to outside world through the residential gateway.
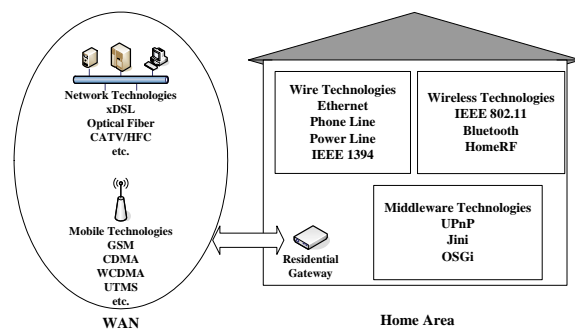

Figure 1.Home networking structure

2.2. Classifications of Home Networking Technologies

In this paper, the home network technologies applied in home may be classified into several parts: wired network technologies, wireless network technologies and middleware technologies. In following sections, some relative home networking technologies will be introduced.

2.2.1. Wired Technologies. Wired technologies mean that using the physical circuit to build the home network. Some wired technologies applied in home area will be introduced at following section.

Ethernet - The most widely used network technology. The Ethernet system construct by twisted-pair, coaxial cable, optical fiber etc. There are many versions of Ethernet standard. The most widely used version of Ethernet technology is 100Mbps twisted-pair.

Phone Line - This technology is focus on using the phone line to build the physical network backbone for the home network. The most famous group in develop this technology is homePNA [4]. At the phone line system, it uses frequency division multiplexed on the same wire as used by the standard analog phone service and digital data transfer service. The transfer speed can reach 10Mbps. The fig.2 shows the phone line system example.
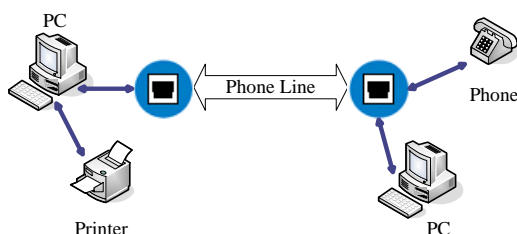

Figure 2.Phone line system example

Power Line - The power line technology uses electronic power wiring in the home as a physical network layer. The power line technology occupies the band from about 4.5 to 21 MHZ. The most famous group in develop power line technology is HomePlug [5]. The bit rate delivered to the MAC by the physical layer is about 14 Mbps. The fig.3 shows the HomePlug system architecture.
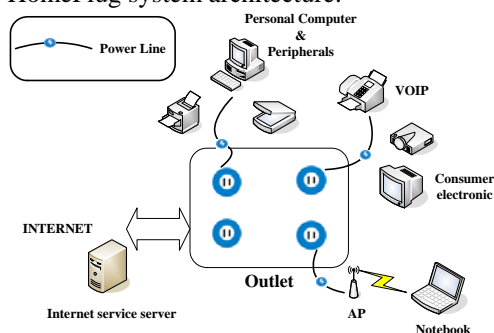

Figure 3.HomePlug system architecture

IEEE 1394 - The IEEE 1394 standard is a high speed peripheral standard use in linking multimedia devices such as video camera and other high-speed device like hard disk drives and printers [6]. It can move large amounts of data between computers and high-speed peripheral devices. The high speed of IEEE 1394 make the standard is adopted by many manufacturers of multimedia devices.

2.2.2 Wireless Technologies. Wireless technologies mean that using the Radio Frequency technologies to build the network connection. The following section will introduce some wireless technologies use in home network.

HomeRF - The HomeRF specification is an open industry specification that allows PCs, peripherals, cell phone and other consumer devices to share and communicate data and voice in home without to layout new wires [7].

IEEE 802.11 - IEEE 802.11 technology is one of the most popular WLAN technologies in the world [8]. The IEEE 802.11 standard works on 2.4GHz band and the transfer rate can reach 11Mbps. 802.11b and 802.11g can reach 54Mbps (slow down with the increasing of range). The wireless communication feature and the high speed performance make the IEEE 802.11 technology become the most popular WLAN technology and befit to use in home area or office building.

Bluetooth - The Bluetooth technology is an open specification that enables short-range wireless connections between desktop computers, notebook computers, computer devices, handhelds, mobile phones, personal digital assistants, and other Bluetooth embedded devices. It operated in a globally available frequency band (2.4GHz) for worldwide compatibility. The theoretical data rate can reach 1Mbit/s. The actual maximum throughput is approximately 400-700 Kbps [9].

2.2.3 Middleware Technologies. The middleware means a layer of software between the network and applications which provides services of network operation.

UPnP - The Universal Plug and Play (UPnP) architecture is announced by UPnP forum in June 2000 [10]. The goal of UPnP is more than just provide a simple extension of plug and play peripheral model in home area. No more driver and use common protocol to build the service system are what the "universal" mean. The UPnP architecture is media independent and operating system independent.

Jini - The Jini Technology was released by Sun Microsystems in January 1999 [11]. The overall goal of the Jini Technology is to make the network into an easily administered, flexible tool for

equipment/service providers or home users. The focus of Jini technology is to make the network a more dynamic entity that better reflects the dynamic nature of the workgroup by enabling the ability to add and delete services flexibly.

2.3 LonWorks Network Technology

The LonWorks technology is promoted by Echelon [2]. The primary goal of LonWorks technology is to make equipments intelligent and interactive to other network devices. Through the LonWorks technology, we can control devices from any where remotely. The LonWorks technology provides a solution to the many problems of designing, building, installing and maintaining device networks.
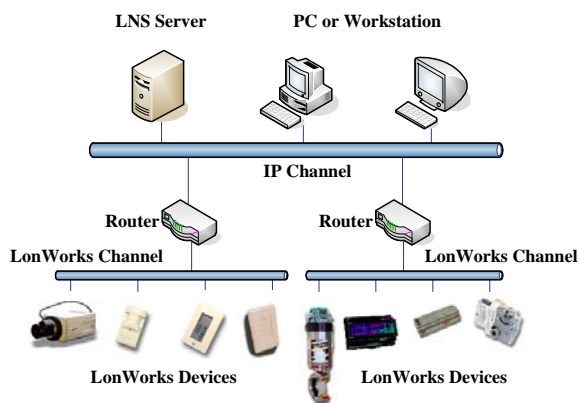

Figure 4.LonWorks network architecture

LonWorks technology provides multiple network media support solutions. Service vendor can easily provide integrated services to customers. After the simplifying of the develop procedure, the LonWorks technology is benefit to the development of home networking service and applications.

2.4 Open Service Gateway Initiative (OSGi)

The Open Service Gateway Initiative (OSGi) was founded in March 1999 [1]. It provides a forum for the development of standards related to broadband network and remote connectivity. This forum is focus on to promote an open service platform for the delivery and management of multiple applications and services to all type of appliance or device in home area, office building, vehicle and other environments.

The OSGi service platform plays an important role between the wide area network and the local area network. A common relationship in which the of the OSGi service platform to the rest of network is shown in Fig. 5. The service platform is the bridge between clients and devices. The OSGi service platform must support service cradle-to-grave life cycle management, inter-service dependencies, data

management, device management, client access, resource management and security.

The OSGi technology has the following advantages [1]:

Platform independent
Application independent
Multiple service support
Multiple network technology support
Reliability
Security
Co-existence with other standards

The OSGi service platform can implemented on many network communication protocols. It makes the service and application develop more quickly and extensively.
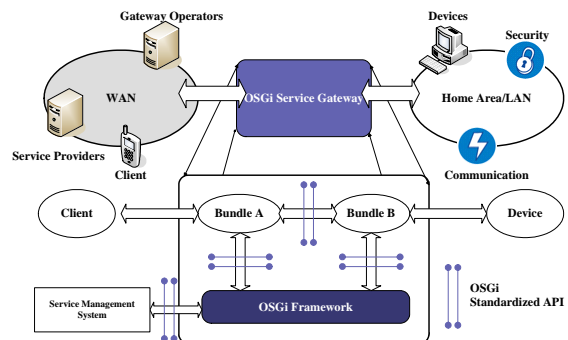

Figure 5.Relationship of OSGi platform and network

2.4.1 OSGi Architecture. The OSGi contains two important components: service framework and bundles [1]. Fig. 6 shows the architecture of OSGi.
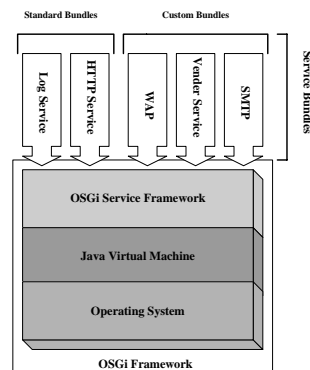

Figure 6.The OSGi System Architecture

Service Framework - The OSGi service framework is a general-purpose Java software framework that supports the deployment of extensible and downloadable service applications called bundles. The framework provides methods that allow service bundles to request and to register services.

Service Bundle - A bundle contains services, Java classes and other related resource. Bundle is deployed by a JAR file and represent as a functional component to install and active on service

framework. A service bundle can be registered or unregistered in the framework registry. One of the OSGi primary features is that the service can appear and disappear at any time.

3. System Organization

According to the demands of home networking which analyzed in the previous section, a home remote control system has been presented in this paper.

3.1 Overall System Architecture

The overall system architecture is shown in Fig. 7. There are three key components of this system: service gateway, home appliances and security monitor system.
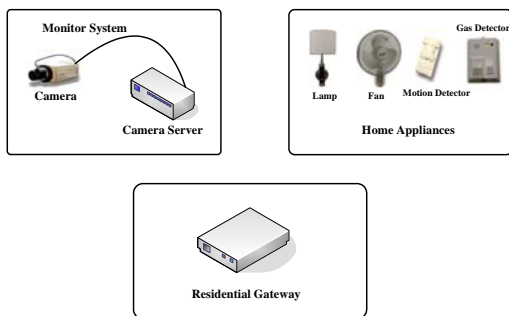
Figure 7.The Overall System Architecture

3.2 The Software Architecture

The system's software architecture is shown in Fig. 8. This software architecture is operating over the residential gateway. The LonWorks Device Control API is a set of classes that provide programmer to query the network variables status and control the network variables [2]. Through control the network variables, service bundles can control LonWorks devices and providing services.
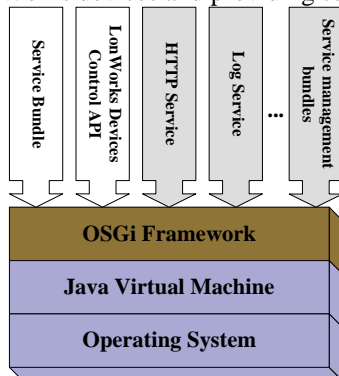
Figure 8.The System Software Architecture

3.3 The System Physical Connection Topology

The physical connection topology is shown in Fig. 9. All devices connect together by power line and twisted-pair line actually.
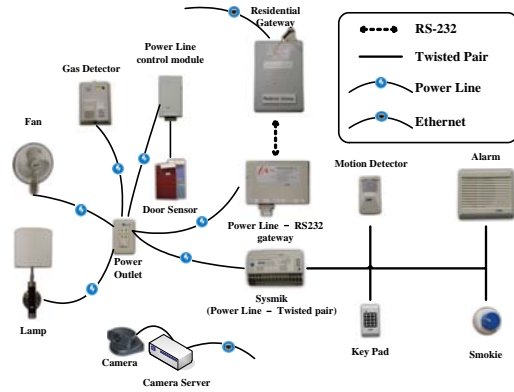
Figure 9.The System Physical Topology

3.4 Implementation Screen Shot

In Fig. 10, the screen shots of system user interface are shown. In the left hand side of this web page is the camera monitor and camera control panel. In the right hand site is the device control panel, device and security status.
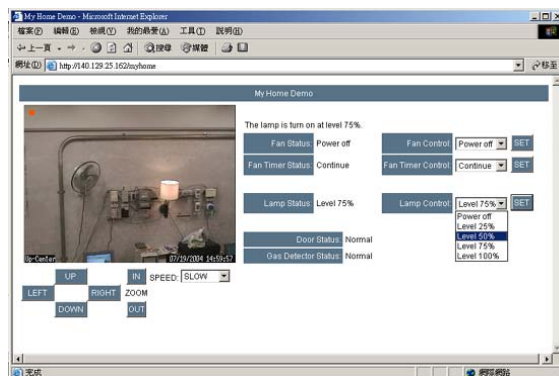
Figure 10.The System Screen Shot

Figure 11.The Operation Demo

4. Discussion

In this paper, a home appliances remote control system based on OSGi has been presented. Some of these problems are founded in this system architecture. For instance, the residential gateway can not provide immediately security notice when the user does not open the web browser to browse the service system web page. In this paper, a compound architecture has been proposed. This system is includes four main components: OSGi

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service gateway, monitor system, home appliances and control system as shown in Fig. 12.
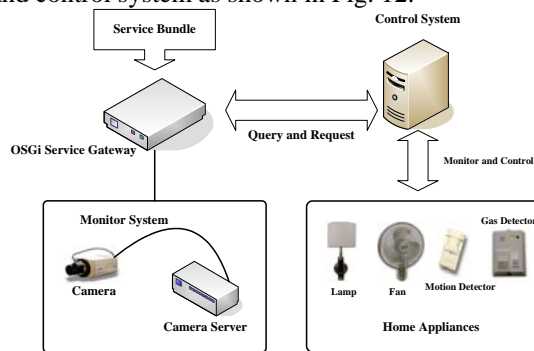

Figure 12.A Compound Architecture

Currently, the home system architecture is in the hypothetical phase. It will be researched and improved continuously.

5. Future Work

With the ceaselessly progress of science and technology, there are more and more home networking technologies have been promoted. The more and more home appliances support the network service. The integration of home networking still has a lot of questions. Currently, this system just supports the LonWorks technology compatible appliances. According to the demands of home networking which analyzed in previous chapters, the trends of home networking will incline to contain multiple technology appliances. How to add more technology appliance supporting will be one of future works in this research.

Reference

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