

## The Development of the Home Control System with the OSGi

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**Abstract:** The home network is the technique to guarantee a safe, economical, socially integrated, and healthy life to the family and it provides domestic safety, instrument control, controllable energy and health monitoring by the connection of the home appliances using wired and wireless networks. A home control system has been developed for managing and controlling home appliances. This paper designs the broadband PLC home controller using broadband PLC technology which can save much cost at a network infrastructure using the existing power line at a home and design the USB home controller using USB technology which is low cost and has many goods with it. And the embedded home server manages those. The CDMA module provides mobile functions to the home control system in this paper. And we choose the OSGi specification which is compatible with other home middleware and can accept various communication techniques of home network

**Keywords:** Home Control System, USB Home Controller, Broadband PLC Home Controller, OSGi

### 1. INTRODUCTION

Recently, with a rapid growth of the internet, the consideration has big movement which uses Internet at control and supervision of the home appliances and equipments. In particular, the need and concern of home network technology is increasing with development of wired and wireless communication system such as broadband PLC (power line communication) [15], IEEE 1394, USB(Universal serial bus)[3], 802.11 and Bluetooth. The home network is the technique to guarantee a safe, economical, socially integrated, and healthy life to the family and it provides domestic safety, instrument control, controllable energy and health monitoring by the connection of the home appliances using wired and wireless networks.

The home network technology is now being studied by many enterprises and laboratories both domestically and internationally. And the history of it is not short. But, despite the large amount of new device being developed, the concrete applications applied at real life are rare because no standards or protocols exist for home network. Soon more well-known companies will be setting international standard. If the standard for the home network diffused at each homes, the home network which will be connected to the external net will be spread and used in every home, and automatically managed through the home network.

This paper designs the broadband PLC home controller using broadband PLC technology which can save much cost at a network infrastructure using the existing power line at a home and it designs the USB home controller using USB technology which is low cost and has many goods with it. And the embedded home server manages those.

The middleware of home network is important as the communication technology of home network. To be representative among this things such have UPnP(Universal Plug and Play) proposed by MicroSoft Inc., HAVi(Home Audio and Video Interoperability) [10] proposed by SONY corp. and 8 household companies, Jini proposed by Sun Microsystem Inc., etc. And this paper choose the OSGi(Open Service Gateway Initiative) Specification which is compatible

with UPnP, HAVi, Jini and can accept various communication techniques of home network

First, this paper explains overall structure of the home control system which uses the OSGi specification and it also explains about each the embedded home server, the USB home controller, the broadband PLC home controller and the CDMA module. Secondly, this paper explains about overall structure of the middleware of the home control system with the OSGi specification, embedded linux[16], the device services and the http service.

### 2. THE HOME CONTROL SYSTEM

The home control system proposed in this paper consists of the embedded home server, the USB home controller, the broadband PLC home controller and the CDMA module as shown in the Figure 1. The embedded home server manages the USB home controller and the broadband PLC home controller and allows external network like remote client terminal to access to the home network.

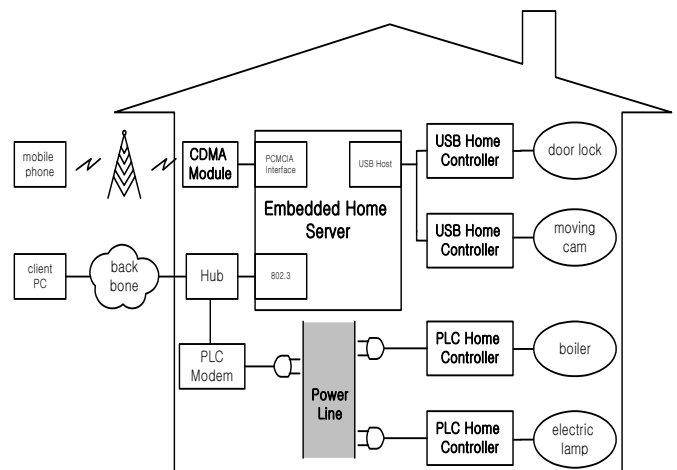


Fig. 1 Overall Structure of the Home Control System

The USB home controller is connected to the home server through a USB bus and it is expansible to more than one. The broadband PLC home controller which is the device based on IP is connected to the home server through a hub and a power line. It can be connected more than one. The both controllers control various home appliance connected to I/O which themselves have. Lastly, the CDMA module makes user take important information of the home control system at any time and any place.

### 2.1 The Embedded Home Server

The embedded home server was designed for the board which contains a USB Host, a PCMCIA interface and An ethernet device as in the Figure 2. The MPU (micro processor unit) uses a SA1110[13] which is a type of ARM[5], and the memories are used a Flash Memory and a SDRAM. A SA1110 as the SOC (system on chip) easily implements an embedded system because it includes various controllers such as a SDRAM controller, a PCMCIA controller, a LCD controller, etc. Also a embedded OS builds in a SA1110 easily because it has a MMU (memory management unit) and instruction sets which can support high level language.

The USB host manages and controls the USB home controller. The USB host can connect the USB home controller up to 127 peripheral devices, and it supports the transmit techniques which are control transfer, bulk transfer, interrupt transfer and isochronous transfer transmit.

The PCMCIA interface offers wireless communication functions inserting wireless communication PC cards such as CDMA PC card, 802.11 PC card, and Bluetooth PC card. The basic design of it can support wireless communication using the CDMA PC card. The ethernet device connects to a back-bone network and the PLC modem through a hub, so it can connect with the home server from a external network and the broadband PLC home controller.

The embedded home server has a 64Mbytes SDRAM and a 32Mbytes Flash Memory and is loading embedded linux, java VM(Virtual Machine)and the OSGi Service-Platform.

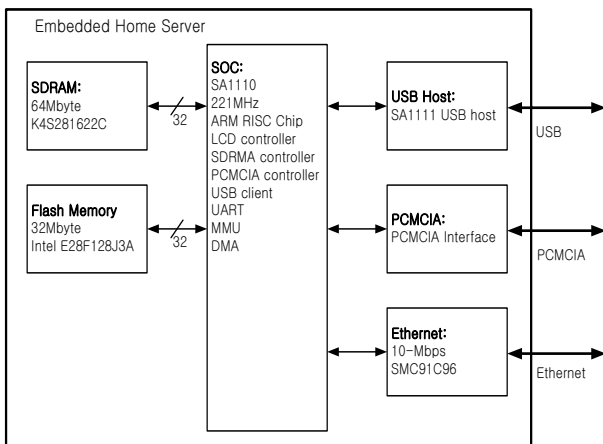


Fig. 2 The embedded home server

### 2.2. The USB Home Controller

The USB home controller has a high speed transmission and a hot-plug which is convenient and expandable. These features of USB technology have recently been in the spotlight.

A PDIUSB12[14] of Phillips corp. is used for a USB SIE(serial interface engine), and a PDIUSB12 supports various data transfer techniques which are control transfer, bulk transfer, interrupt transfer and isochronous transfer. The

control transfer is a protocol that allows a host to read the configuration of the USB device. The bulk transfer is used for irregular amount of data transmission, and it can also analyze errors. The interrupt transfer is a protocol that regularly sends small amounts of data and is used by a simple controller. The isochronous transfer is used for the practical application which is more important to isochronous data flow than accuracy. The isochronous transfer has some of following features: 1) It guarantees data transmission bandwidth. 2) It insures data transmission speed. 3) It does not retransmit, even though some errors may occur during transmission. Thus the isochronous transfer focuses on real-time data transmission with some errors during transmission.

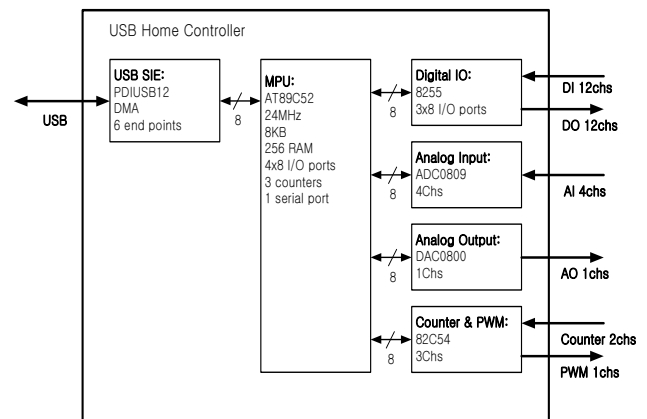


Fig. 3 The USB home controller

The USB home controller has a digital input of 12chs, a digital output of 12chs, an analog input of 4chs, an analog output of 1ch, a PWM of 1ch, and I/O of counter 2chs as in the Figure 3. And the electric specification of I/O is shown in the Table 1. The USB home controller can control various domestic appliances such as a auto door lock, a heating and boiler equipment etc because it supports various features of input and output as well as the method of transmission

Table 1 The I/O spec. of USB home controller

I/O	Chan nel	Input spec.	Output spec.	Resol ving	Etc
DI	12chs	TTL level (5V)	-	-	-
DO	12chs	-	TTL level (5V)	-	-
AI	4chs	0 - +5V	-	8bit	samplin g:100us
AO	1chs	-	althernativ e current	8bits	samplin g:100ns
Count er	2chs	Maximu m 8MHz	-	-	16bits couner
PWM	1chs	-	Maximum 8Mhz	-	16bits PWM

### 2.3. The Broadband PLC Home Controller

This device easily connects to home appliances using the power line laid in a home and it easily participates in a home network because it is a device based on IP. Also it is embedded in a home appliance through little modification.

The MCU(Micro Center Unit) of the broadband PLC home controller is a SAMSUNG of S3C4510B[12] which is NetARM built-in a ethernet controller. The broadband PLC home controller uses the Intellon's INT51X1[9] which is HomePlug 1.0[9] compliant chipset for broadband power line

communication. The S3C4510B connected to INT51X1 through MII as in the Figure 4.

The broadband PLC home controller has a 16Mbytes SDRAM and a 1Mbytes ROM and it is installed uClinux because has not a MMU. The Application of the broadband PLC home controller consists of the program to manage the status and privacy of power line network, the jini technology IP interconnect specification[8] compliant socket program offering to network PnP and the program which interpret commands of the embedded home server and a control home appliance connected with itself I/O.

The I/O specification of the broadband PLC home controller is designed to have various I/O features for various home appliances like the USB home controller It is same to the Table 1.

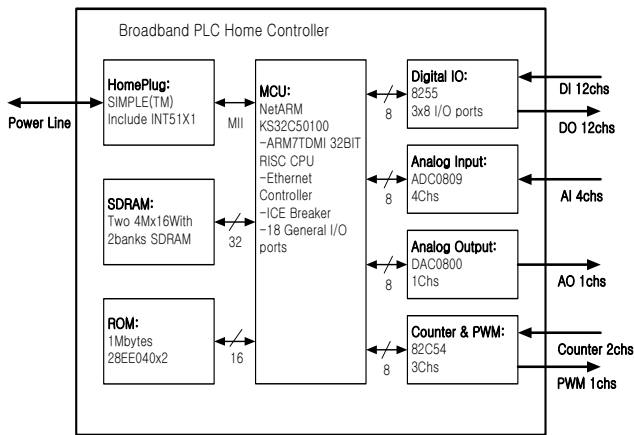


Fig. 4 The broadband PLC home controller

### 2.4. The CDMA Module

The CDMA module united with data communication and sound communication is developing as the next generation of broadband wireless communication. It will soon unite with wired/wireless PSTN and wired/wireless internet, as well as international unity. Consequently, we can connect to the home network using our own a mobile terminal without the limits of time and place. The CDMA module has features as shown in the Table 2.

The CDMA supports wireless internet using PPP and 1:1 data communication. When the home control system experiences events such as invasion by force, the embedded home server immediately signals the manager's cellular phone using SMS.

Table 2 the spec. of CDMA module

Connecting method	CDMA
CDMA	IS-95B
Speed	64kbps
Receive method	Double super heterodyne
Receive freq.	869MHz – 894MHz
Receive sensibility	Less than -104 dBm
Transmit method	AM
Transmit freq.	824MHz – 849MHz
Regulated voltage	DC 5V

### 3. The Middleware of the Home Control System with the OSGi

The OSGi standard specification which can be accepted various wired or wireless network technology such as Bluetooth, HAVi, HomePNA, HomeRF, IEEE1394, LonWorks, USB, PLC, etc., is the most inclusive open network technology. Especially, the OSGi specification also accepts function offered Jini, UPnP, HAVi, etc., in order for appearance of totally new-concept-device.

Until now, we considered connecting techniques(USB, PLC, Internet, CDMA) of the home control system and the functions of the devices. The Figure 5. shows valid services which are taken by connection and control of these devices. The OSGi service-platform offers the environment to work these services.

The OSGi service[6] is a component which can be access to use defined service interface. An application is composed by operations of several services. The framework[6] has mapping for each services and concrete operations of these services. We find out concrete operations of these services through a simple query mechanism. And also, the framework manages interdependence of each service.

In this paper, proposed the home control system offers the http service which can that a external client access to home network using a browser and it can access to the services which are the broadband PLC home controller service managing the broadband PLC home controller, the USB home controller service managing the USB home controller and the SMS sending service like the figure.5.

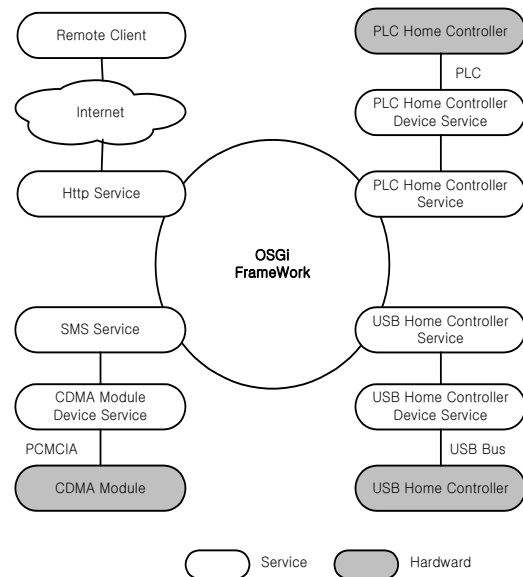


Fig. 5 The Middleware of the Home Control System

### 3.1. The OSGi and Embedded Linux

The OSGi service-platform is operated on Java VM. The Java VM performs roles of the intercession for the difference of between each different embedded OS and system. A physical unit named bundle[6] includes the OSGi service. Several OSGi services are included in a bundle, too, and the bundle is able to make up a standard unit of the distribution and management. In this paper, proposed the home control system has the web service bundle, the CDMA module bundle, the PLC home controller bundle and the USB home controller bundle the same as the Figure 6.

The thing that managed these Bundles is the framework. The framework performs registration, search, execution and delete

of those with the service registry. And also, the framework performs an event detection and transaction. These events are not physical events generated from a device but logical events base on an event production such as the service, the bundle and the framework.

Embedded linux means 'linux developed the embedded system which is had low capacity and small size memory'. E embedded linux performs multi tasking, network, multimedia and the interface between a hardware and a application(Java VM) through a device driver. The device driver[2] is the kernel inner function managed data transference between a device and a system memory. Generally, the device driver has a file system and an interface in higher part and existed device hardware and a interface in lower part.

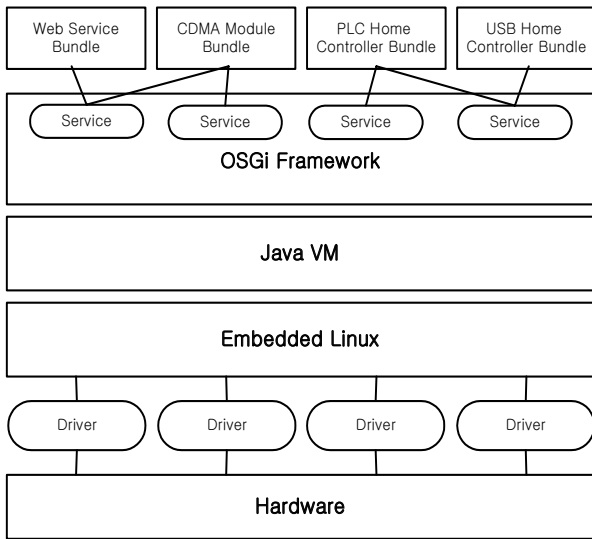


Fig. 6 The OSGi and the Embedded Linux

**3.2.The Device Services**

The device service proffers the interface between the home control system services on the OSGi service-platform and the device drivers managed all kinds of hardware on the embedded linux. In this paper, proposed the home control system has the USB home controller device service, the broadband PLC home controller device service and the CDMA module device service the same as the Figure 7.

The USB home controller device service exists between USB home controller service and USB home controller device driver. It offers the interface each other and uses a JNI(Java native interface)[11] for access to the USB home controller device driver.

The broadband PLC home controller device service is designed the jini surrogate host[7] program satisfied the jini technology IP interconnect protocol and the socket program controlled the broadband PLC home controller. So, the broadband PLC home controller device service can find and manage the broadband PLC home controller in a home network.

The CDMA module connects to the embedded home server through a PCMCIA bus and is recognized a serial device driver. The CDMA module device service offers the interface each other and it exists between the SMS service and the serial device driver. We are used with the JNI by the interface at the CDMA module device service and the serial device driver.

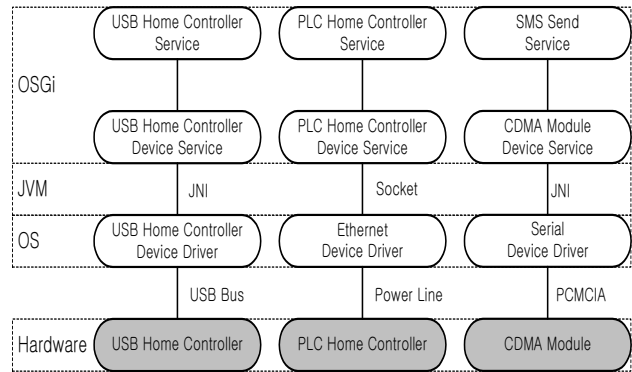


Fig. 7 The device serives

**3.3. The Http Service**

The user interface for client is designed a servlet[6] based on web. The servlet is the object implemented a java servlet API and the http service can be accessible to designed the servlet through the http. The http service can connect with the embedded home server using web browser without a particular program from client terminal and it is able to connect internet whenever and wherever.

The user can be easily managed home control system by using servlet program which is interoperated the USB home controller service, the broadband PLC home controller service and SMS service as figure 8.

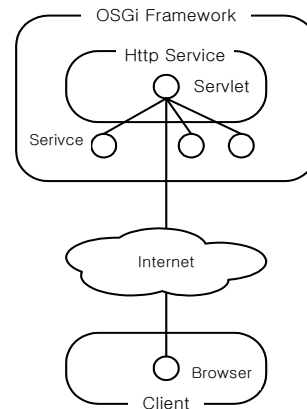


Fig. 8 The http service

**4. CONCLUSION**

In this paper, proposed the home control system consists of the embedded home server, the USB home controller, the broadband PLC home controller and CDMA module. The USB home controller and the broadband PLC home controller control various electric home appliances. The embedded home server manages those and offers wired/wireless internet and the SMS service using the ethernet device and the CDMA module.

And also, the embedded home server with the embedded linux and the OSGi service-platform manages the device driver each other and services. It makes a external client having a web browser possible a home networking using the http service and the servlet.

The USB home controller is adaptable about a control object which has the different character with expansion and facility

of the USB. Thus it is designed with the several I/O. The PLC home controller can easily construct a network infra-structure as not only using an existent power line but also it is a device based on IP using the HomePlug technology. So, we expect that it is possible the USB home controller and the broadband PLC home controller as the control module managed a home control part on electric home appliances.

In this paper, we accept a USB technique and a broadband PLC technique of many home networking communication techniques and we build the home control system model using the OSGi service-platform which is suitable compatibility and expansion in a part of a home networking middleware. Thus our proposed home network technology will become a good example of a home network which will have many development and integral of a technology from now on.

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