

U-Home Network Architecture Based on Cloud Computing

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ABSTRACT

According to the recent advancement of wired and wireless communication network technology such as mobile communication and high-speed Internet, home network service base on Internet information appliance makes great strides. Particularly, the UPnP based technology that guarantees QoS (Quality of Service) for heterogeneous devices is now applied to the development of various home network services. When constructing a home network environment, management functions to register, connect, and delete all the devices on home network are very important elements in order to exchange data and convert services among heterogeneous devices. Hence, this paper defines a new paradigm as *Consumer Electronic as a Service* (CEaaS) using cloud computing for next-generation ubiquitous network environments and propose a new u-home network architecture. The proposed architecture is implemented as a smart phone web interface using HTML 5.

Categories and Subject Descriptors

B.2.0 [Arithmetic and Logic Structures]: General.

General Terms

Design

Keywords

Ubiquitous network, cloud computing, u-home, u-city, HTML5

1. INTRODUCTION

IT (information technology) technology is an essential element in the overall sector of our society such as traffic, industry, and economy. Recently, studies are actively made for raising the competitiveness of cities and the quality of life through u-city (ubiquitous-city) technology that combines today's leading-edge technologies such as IT, ET (environmental technology), BT (bio technology) and MNS (micro & nano system) [1].

Particularly, cloud computing service in issue, which is one of the next-generation ubiquitous network environments, integrates

IT resources located physically at different places through virtualization technology to provide an environment to be appropriate for user's demand. In other words, it provides an environment where user can use various IT resources (software, memory, server, network, etc.) through virtualization technology. Such cloud computing service can provide basic services: SaaS (software as a service), PaaS (platform as a service), and IaaS (infrastructure as a service). It can also provide various services under the frame of XaaS. Users can use any service they want anytime and at any place [2].

This paper defines a new paradigm as CEaaS (consumer electronic as a service) using cloud computing technology and newly designed a u-home network architecture. U-home network is designed to be controlled by smart phone widely in use, and the interface for smart phone interface is designed using HTML5 which is spotlighted as a leading-edge technology in order to provide convenient interface to users.

The organization of this paper is as follows. In Chapter 2, home network system and cloud computing are addressed, and the newly defined CEaaS is explained. In Chapter 3, we propose the home network architecture based on cloud computing. In Chapter 4, a user interface that enables home network service by connecting to home server in house remotely, using a smart phone and HTML5 is designed. In Chapter 5, a brief conclusion is presented.

2. Related Works

2.1 Home Network System

There are various forms of home appliances in house such as light, air conditioner, fan, ventilator, TV and radio. Those devices can be controlled conveniently by constructing a home network. Home network is a system where all of home appliances in a house are connected each other to exchange information and operate by themselves through embedded system it can be controlled by user's specific motion or voice in house or by terminals remotely from outside. Such home network system provides user-oriented on-demand service without being affected by space and time limitation. Home network service consists of home gateway, internal network, external network, and home appliances in house. In order to access the system remotely, a middleware is required. Middleware take a role of intermediate connection between users and devices, and there are Jini, Havi, OSGi, UPnP, etc [2].

2.2 Cloud Computing

Cloud computing is an Internet-based technology that integrates computing resources such as software and memory through virtualization. By cloud computing, each computer resource is integrated into one service to be provided to users. Users can select, only one necessary service among various services provided in cloud computing environment anytime and at any place. By cloud computing, service provider can construct systems flexibly with necessary computing resources according to the change of user's demands, and users just pay for the service as much as they use without the initial expense for the installation of the system [3].

2.3 UPnP

Microsoft's home network standard protocol is UPnP. UPnP makes it possible to browse automatically the services provided by home appliances in a house. If a new home appliance is added in a home network, it is automatically detected without any setting for connection and the functions of this new appliance are informed to other appliances so that users can easily add or delete devices. UPnP's network has 6 phases: addressing, discovery, description, control, eventing, and presentation [4].

2.4 HTML 5

The standard of next-generation HTML is HTML5. It is now announced up to 5.1 Draft version and major web browser companies such as MS, Apple, Mozilla, Google and Opera participated in this development.

The major functions of HTML5 are as follows: video audio function that does not require Plug-in, canvas function that can realize multi-dimensional graphic, and geo-location function based on global positioning system service. It has an advantage that it is not dependent on any device but able to be used in various environments [5].

3. U-Home Network Architecture

The most important factor in the home network architecture based on cloud computing is the virtualization and management of home appliances that are physically scattered in a house into one resource. Cloud computing middleware is necessary to manage home appliances as one resource, and it is also necessary to unify the operating systems of home appliances so that home appliances can communicate through middleware efficiently. If system environment is not unified, each operating system of host home appliances should be satisfied individually. This will cause huge expense to construct a home network and the feasibility for adding a new home appliance will be limited.

3.1 Existing Home Network UPnP Middleware

Figure 1 shows the architecture of home network service in existing UPnP middleware. In this architecture, since all the services provided on home network are supposed to be shared

with all users who have an access authority to the home network, it is very difficult for individual user to find any service of appliance they need and it would take a lot of time. For example, let's assume that there are one TV in main room and other TV's in small rooms with other various home appliances. When a user sends a command of middleware to switch off the TV in main room, the search for the middleware for the exact TV in main room would require complicated procedures.

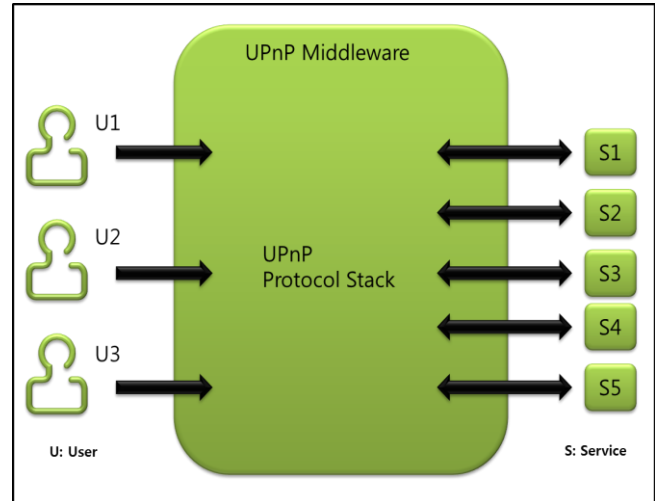


Figure 1. Home network service architecture of UPnP middleware [4].

3.2 CEaaS

As the elements of u-home network, there are various home appliances such as gas, light, air conditioner, and TV. Such home appliances have more than one function such as turn on/off, record, and etc. Each function can be considered as one service. The CEaaS (consumer electronics as a service) which is newly defined in this paper, provides the functions of home appliances requested by users as one integrated service. Users can select any service they want, anytime and at any place through various interfaces, and send commands to home network middleware for home appliances.

3.3 Home Network Architecture Based on Cloud Computing

Figure 2 shows an architecture that provides home network service using the cloud computing middleware. This architecture is used in the proposed CEaaS that is newly defined for the existing UPnP middleware. Without sharing all home appliances, user can be provided only the requested service. In this architecture, only the requested service is virtualized and formed as a block. Each user can verify and use only the requested service in the block. Instead of sharing and searching for all the services, users can search only the services they want so that searching time can be reduced significantly.

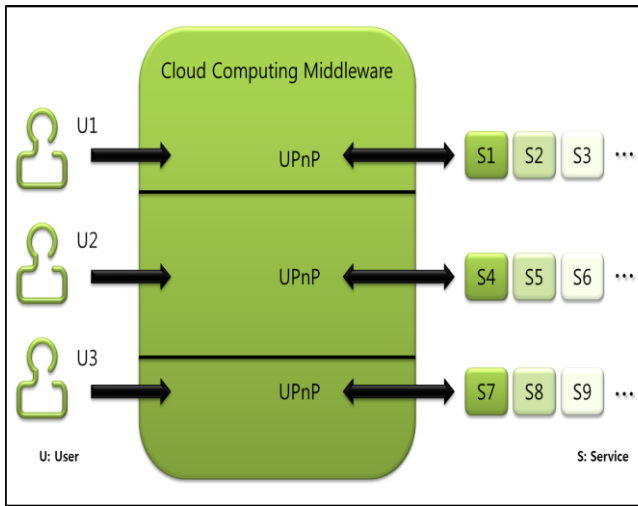


Figure 2. Home network architecture based on cloud computing middleware.

3.4 Proposed Home Network Architecture Based on Cloud Computing

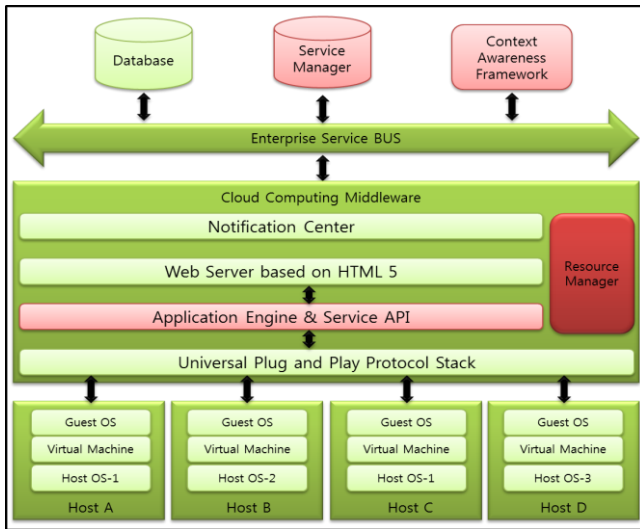


Figure 3. Proposed home network architecture based on cloud computing.

Figure 3 shows the proposed based on cloud computing home network architecture.

1. Service Manager manages the services provided from home network system.
2. Context Awareness Framework detects the state of home appliances through sensors and gives a notice to Resource Manager whenever any change in the state occurs.
3. When receiving a message from Context Awareness Framework, Resource Manager changes the state information of home appliances and transfers the message to Notification Center.

4. Notification Center notifies the user for the current state change of home appliance through Push service.
5. In order to execute the CEaaS service selected by the user, Middleware calls Application Engine & Service API and execute the relevant service of host appliance via UPnP Protocol stack.

4. Interface using HTML5

In this section, a three-dimensional (3-D) virtual home interface that requires high-performance processing using cloud computing power is presented. A 3-D virtual home interface is implemented through HTML5 Canvas API. User can access the 3-D virtual home interface anytime and at any place through a smart phone Web App and use CEaaS service. Due to the characteristic of Web App, it is not dependent on the smart phone OS, and complicated calculation can be run by cloud computing middleware so that it can be executed even in a low-performance smart phone. Figure 4 shows the 3-D virtual home interface based on HTML5 that realizes the home network architecture using the home network architecture based on cloud computing in Figure 3.

Now an example flow of the implemented system is explained. The initialization of the application and the interface in Figure 4 implemented is executed through a smart phone. The Context Awareness Framework in Figure 3 detects any abnormal state of gas stove. The Notification Center transmits the Push messages to the user. The user reads the message and recognizes the situation through the message and selects the Off service of gas stove through the interface. Middleware calls the Off service API of the gas stove and executes the relevant service.

5. Conclusion

In this paper, a new u-home network architecture is proposed using cloud computing technology, for next-generation ubiquitous network environments, and a 3-D virtual home interface is implemented through HTML5 Canvas API. User can control home network anytime and at any place by accessing the interface through a smartphone Web App and by selecting the appropriate service using CEaaS.

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Figure 4. 3D virtual home interface

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