A Novel Digital Device Monitoring System Using UPnP Cloud Architecture

Yun Cui[1], and Hanku Lee[2]

***Abstract*—**Nowadays, UPnP technology is exploited to variety of digital devices for sharing multimedia contents, monitoring and controlling home appliances. For improving UPnP service fit for IT development speed, UPnP Forum released a new service standard named UPnP cloud architecture. In this paper, we propose a digital device monitoring system based on UPnP cloud architecture. The proposed system is built by XMPP instead of HTTP in UDA. XMPP supports more comfortable service environment to communicate with each device. UPnP cloud architecture is composed of UCS, UCCD, and UCC-CP for monitoring devices.

***Keywords*—**UPnP, UCA, XMPP, UCCD, UCC-CP

I. Introduction

WITH the unfolding of the information age, for providing home network functions, multimedia devices support services to share and play multimedia content by using DLNA (Digital Living Network Alliance). DLNA is a standard for transmit and play multimedia content based on UAA (UPnP AV Architecture) in a home network. Therefore, DLNA is a particular service of UPnP. Digital devices, which support UPnP, exploit a basement architecture named UDA (UPnP Device Architecture) to control or be controlled. The main function of UDA is to control digital devices for supporting users a comfortable home controlling system. However, there is a limitation in UDA 1.0 is the functions just are supported in a local network. UDA 1.0 also doesn't be used for cloud services such as PaaS and SaaS because of its architecture. In order to overcome the limitations, UPnP Forum released UCA (UPnP Cloud Architecture) in UDA 2.0. UCA is a new idea to make communication among digital devices different from UDA 1.0. It is not restricted to local network. Based on UCA, we implemented a completely new digital devices monitoring system.

The proposed system can monitor the status of digital devices any time, and anywhere. Those digital devices must support UCA functions for connecting each other. UCA provides XMPP (Extensible Messaging and Presence Protocol) instead of SSDP (Simple Service Discovery Protocol), GENA (General Event Notification Architecture), and HTTP. XMPP is used for chat programs. By using XMPP, proposed system is not limited to local network, and also reduces the complexity in handling multiple protocols.

The remainder of this paper is organized as follows. Section 2 discusses related studies, home networks, and smart homes. Section 3 gives a detail explanation about the system architecture. Then, Section 4 describes the implementation of the system. Section 5 concludes this paper.

II. Related Work

Many researchers have proposed methods for controlling digital devices and using their service functions outside of a local network [2, 3, 5]. A system that utilizes a ubiquitous data source server (UDSS)—a sensor device for home networks—for use by sensors in the home, has also been proposed [1]. In the proposed system, by connecting a sensor to an ordinary home appliance and using the values acquired by the sensor, control of the home appliance is made possible. However, to achieve cooperative behavior like this, configuring that behavior directly on a PC connected to the sensor device is necessary. Configuration of a behavior cannot be performed from outside of the home, which is very inconvenient [1]. In [4], Kang et al. implemented an UPnP AV architectural multimedia system using a home gateway supported by the OSGi platform to provide internal and external multimedia services. In their system, they used the UPnP bundle of OSGi to provide users with an external multimedia streaming service. The multimedia services are provided by a multimedia sharing system based on the UPnP AV Architecture [6]. Although the system was implemented using OSGi, due to congested multimedia content, the system could not support a large amount of multimedia data storing and management approaches. The systems are good for connect from outside of local network, but it is too heavy to manage services.

UPnP Cloud Architecture is an extension to the basic UPnP architecture enabling device to device connectivity across the internet [7]. It exploits XMPP to be a solution for making a simple communication between devices instead of SSDP, GENA, and HTTP are used to UDA 1.0. UCA is composed of servers and devices. Server is named UCS (UPnP Cloud Server) to store information about devices and services. Devices include UCCD (UPnP Cloud Capable Device) and UCC-CP (UPnP Cloud Capable Control Point). By using UCA, proposed system can be improved service capabilities.

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III. Proposed System

The proposed system provides functions of UCS, UCCD, and UCC-CP to users for monitoring UCCD by using UCC-CP. It also supports real-time monitoring service to user outside of local networks for checking status change to easy control UCCD.

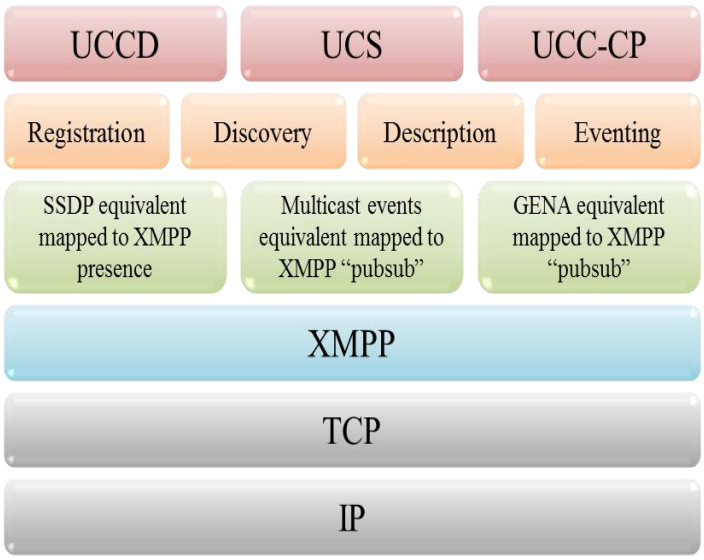

Fig. 1 Structure of proposed system

Main protocol of the system is XMPP. For easily of use UPnP service, the system is designed to use XMPP presence function instead of SSDP for getting information of devices and services and XMPP PubSub instead of GENA for gathering multi event across the internet.

A. Registration

To register to UCS, all devices must get a JID from UCS supported by XMPP. JID is a unique number, and is composed to local part, domain part, and resource part. Local part is the name of the device for connecting with UCS. Domain part is the name of UCS. Resource part is a description of the device to distinguish from other devices. Therefore, a device requests a JID to UCS, and gets a unique numbers of JID for registering to the UCS. Especially resource part is divided three parts to differentiate between UCCD and UCC-CP. First one is the URL of the UCS. Second part is a series of characters for UCCD or UCC-CP. Last part is UUID made by UCS for connecting with UDA 1.0. UCA also supports two kinds of JID named bare JID and full JID. Bare JID is to distinguish users, and full JID is to distinguish devices of users. UCCD and UCC-CP get JID, register to UCS.

B. Discovery and Description

UCCD and UCC-CP wait for the presence information message transmitted from UCS and response to it periodically. Using XMPP presence function, UCS communicates with devices for monitoring the status. UCS receives discovery requirement with bare JID from UCC-CP. It collects full JIDs that match to bare JID and transmits them to the UCC-CP.

UCC-CP displays the list of devices on the screen to be select by users. UCC-CP requests a description of UCCD selected by users. Then UCCD responses the description requirement to UCC-CP. Description information of UCCD includes many kinds of detail information of the services. UCC-CP gets the description and displays the service information to users. The proposed system provides discovery and description functions as above by using comfortable and easily communication protocol via UCS.

C. Eventing (PubSub)

UCC-CP gets the description of a UCCD, can get the items information of UCCD by using authorization. The authorization of items is supported by roaster function of XMPP. Items are service functions provided by UCCD. Assuming that UCCD is a refrigerator, items are like temperature, food information, and location of refrigerator. UCA provides XMPP PubSub (Publication – Subscription) for transmitting items information between UCCD and UCC-CP. UCCD publishes items across the internet via PubSub. For monitoring the items, UCC-CP requests the monitoring service to UCCD using full JID through PubSub. It is a UCCD subscription. UCC-CP can monitor the items of UCCD over permission.

The main functions of the proposed system are completed through the above process.

IV. Implementation of Proposed System

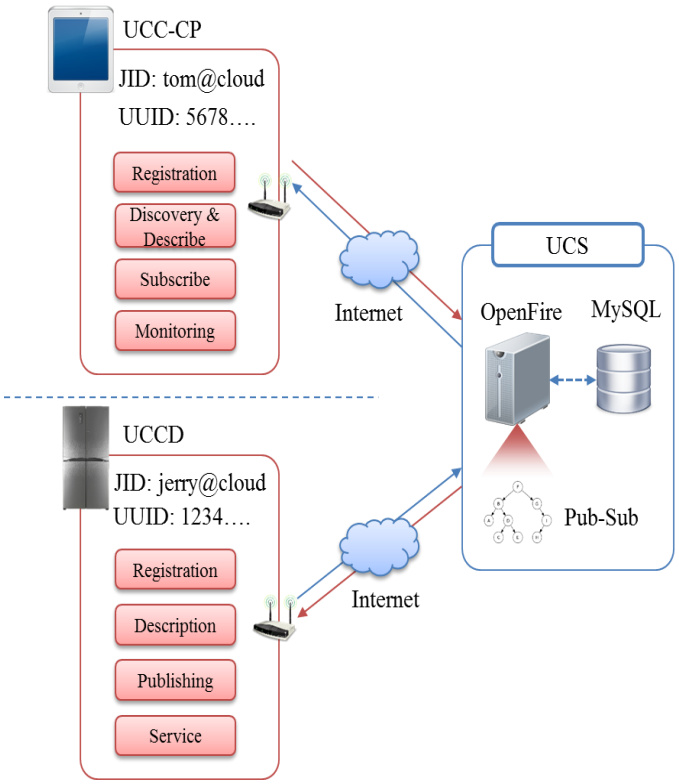

Fig. 2 Architecture of proposed system

Proposed system is implemented by using Apache Smack and Openfire. Smack is an open source software to support XMPP standard. Openfire is a XMPP server program, also is an open

source. MySQL is used for a database connected with Openfire. UCS stores devices information included items by using Openfire and MySQL. UCC-CP and UCCD are implemented by using Smack open source. Figure 2 is architecture of proposed system.

V. Conclusion

Proposed system provides digital device monitoring service via UCA. User can easily monitor devices connected with UCS anytime; anywhere using the UCC-CP. UCC-CP also supports a comfortable control service to the users. Through UCA technology, UPnP will be used for IoT and cloud computing in future.

For future work, we will focus on a fully functional implementation of UCA for controlling devices and also research a methodology that can be applied to the cloud-based IoT services.

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