

The Design of Smart Home Platform Based on Cloud Computing

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Abstract—The smart home is a concept of the pervasive computing, and it gradually becomes significant for the people living in the high technology area. For numerous data and complex control bring about a much heavy burden on the local computers, and it is difficult for the users to obtain the information of the smart home. In this paper, we propose the smart home structure based on Cloud Computing, which helps to reduce local workload and the users obtain the real time information through Web browser directly. In addition, we build the experimental platform to validate the structure of smart home based on Cloud Computing, the experimental results show that the proposed structure of smart home is more convenient, flexible, high efficiency and low cost. Though experiment, we find that the structure based on Cloud Computing is available and has a widespread scope of applications. Furthermore, the Cloud Computing provides plentiful network resource, and guarantees the users data security.

Keywords—smart home; Cloud Computing; Java Servlet; Google App Engine

I. INTRODUCTION

The smart home makes use of the integrated wiring technology, communication technology, and control technique to build efficient facility of tenement and the management system of daily concerns in order to promote the security, convenience, amenity and environmental protection in the family environment. With great amount of the household appliances used electronic technique come in ordinary home, the task of the smart home system becomes numerous and heavy. However, development of the Cloud Computing improves the capability of computer arithmetic and the convenience for the users. Cloud Computing is a large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet[1]. In this paper we design a smart home system based on Cloud Computing hinting at we will not compute on local computers, but on centralized facilities operate by third-party compute and storage utilities. In this paper we design a model to achieve the application of Cloud Computing in the smart home. In the section II, we introduce the related works about Cloud Computing and the smart home. In the section III, we describe the model of the

smart home based on Cloud Computing we designed which improves the flexibility and mobile to the smart home and reduce the cost. At section IV we give the process of experiment and the experimental results is shown.

II. RELATED WORKS

In recently years, the Cloud Computing and The internet of things technology are developing rapidly. Both them aim at providing plentiful resources and convenient life style. In this paper, we combine the application of smart home with the work pattern of Cloud Computing to prepare for proposing the smart home based on Cloud Computing.

A. Cloud Computing

Cloud Computing has become another key technology after Web 2.0. Cloud Computing is a specialized distributed computing paradigm [1] [2] and it is driven by economies of scale [3], and it can solve the problem of increasing computing and data storage. Cloud Computing currently emerges as a hot topic due to its abilities to offer dynamic IT infrastructures, QoS guaranteed computing environments and configurable software services. In recently years, the research about Cloud Computing is embarked by scholars from various countries, and we get abundant knowledge from their papers: we get a summary of an assimilation of cloud computing with a classification of its components and their relationships [4]. The platform of Cloud Computing is introduced to us, for example, the Cumulus project with its various aspects included test bed, infrastructure, middleware and application models [5]; Cloud Computing software consists of the Sector storage cloud and the Sphere compute cloud [12]; the cloud management system software-Phoenix Cloud to consolidate heterogeneous computing loads on shared cluster system. We use the Cloud Computing to complete the complex data processing, and offer the web interface for users.

B. The Java Servlet Environment

Java Servlet [11] is a module dynamic loaded, Google App Engine runs Java web application using a Java 6 JVM in a safe “sandboxed” environment. App Engine invokes app's Servlet classes to handle requests and prepare responses in this environment.

The life cycle of a Servlet has three processes:

Initialization of Servlet. Servlet is a class. When it is first requested by user, Web Service generates an object of

Servlet Class, and loading the object, invoking the init () method to complete initialization.

The object above invokes service () method to respond the request.

The object of Servlet class will exist in System Memory resident since generated first until the Web Service is closed; the Servlet object is get from System Memory when to respond when requested again and again. When Web Service is closed, the system invokes destroy () method to destroy the object.

In the three processes above, init () method is invoked only once when first request; service () method is invoked every time when request; destroy () method is invoked only once when Web Service is closed. The processes invoked are shown in figure 1.

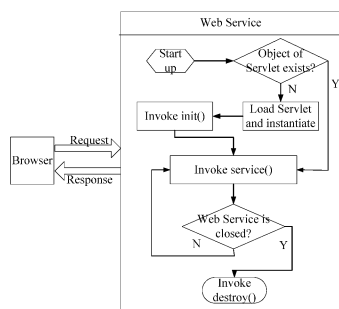


Figure 1. The life cycle of a Servlet

C. The smart home

The concept of smart home plays a significant role in the future research for intelligent life of people in the computer age. The smart home which refers to smart space environment built at digital home is a conception in pervasive computing [6]. Smart home networks technology is available in three main areas: Powerline, Busline and Radio Frequency (RF) [7]. Nowadays, the research of smart home is carried out in a deep-going way. Some scholars propose some service models for smart home, such as a calendar oriented service for smart home to support ambient intelligent and integrated function [8], the interactive smart home simulator focusing on controlling and simulating the behavior of an intelligent house [9], and intelligent oven in smart home environment for manipulating recommended healthy recipe choices to suit each family member health concerns [10]. However, we introduce the method to control the smart home and process the heterogeneous data from the smart with Cloud Computing so the efficiency and flexibility of the system is increased, and the cost and calculated amount of local computers is decreased.

III. STRUCTURE OF SMART HOME CLOUD

The main functional component of the smart home is embedded intelligent gateway, which use the C/S operating mode. Providing Web services in the embedded intelligent gateway, there is contradiction between the performance and the cost, and the resource is wasted seriously. However, with the generation of the Cloud Computing, this situation is

changed. The advantage of Cloud Computing is that every person can make typical Web services in the fictitious network resource, and the one-stop service such as information security, distribution of resource according to one's needs, data parallel computing, high-capacity storage are in the charge of the service provider of Cloud Computing. In this paper, we realize the smart home based on B/S service model with Cloud Computing. The platform of smart home based on Cloud Computing is shown in figure 2. A protocol converter is proposed in this paper in order to simplify the existing mature embedded intelligent gateway of the smart home, and its functions as follows:

Protocol conversion. Adapting all type of internal network of smart home, such as ZigBee, Ethernet and Bluetooth. Achieving data transmission pellucid.

Supplying the raw data for Web Server through communicating with intelligent-agency lying in the PaaS layer of cloud computing.

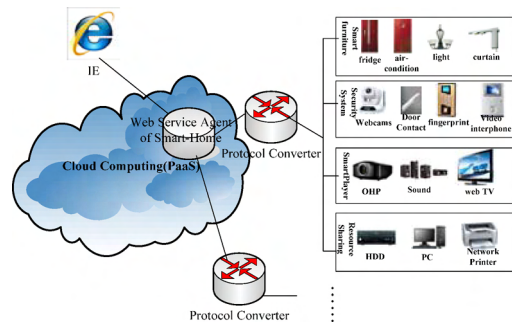


Figure 2. The overall structure of smart-home based on Cloud Computing

Smart home is connected with home Web proxy, which is based on the PaaS [12] of the Cloud Computing platform through the protocol converter, and provides the Web services to users. The Cloud of smart home is divided into three layers; the architecture is shown in figure 3.

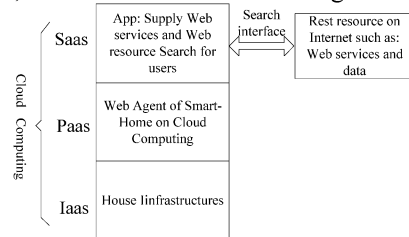


Figure 3. Layered Architecture of smart-home Cloud

The infrastructure of the smart home is located in the IaaS layer of Cloud Computing, which provides support, context-aware, and performance for the in-house network, for example, the electrical equipment control based on ZigBee [13][14], the AV security system, and LAN. The Cloud Computing Web proxy of smart home is located in the PaaS layer, it uses the existing Web service standard of Cloud Computing platform, such as Java Servlet Web service standard of Google, responds the request of browser, analysis of HTTP protocol and the classification, storage and query of network resource. Cloud Computing application layer of smart home provides uniform HTTP page service for

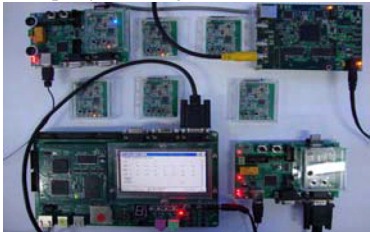
users to manage the furniture in their own house. In addition, the application layer accesses other resource on the internet through the retrieval interface, such as the URL Fetch service provided by Google. The supervisory service in smart home is enriched by the Cloud Computing application layer of smart home; above all, it separates the home service from the other service on the Cloud Computing platform to ensure the security of the accessing to smart home.

The function of gateway is simplified by the platform of the smart home based on Cloud Computing, the numerous data is stored and processed in the fictitious network space. The smart home Cloud supplies convenient and affluent user interfaces of Web services. Distribution according to needs of Cloud Computing not only ensures efficiency of services, but also reduces the cost of Web services to minimum.

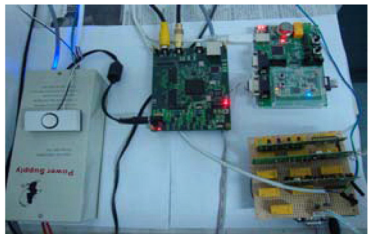
IV. THE EXPERIMENTAL RESULTS

In this paper we provide the smart home Web services based on Cloud Computing to users on the PaaS platform supplied by Google, building a platform of smart home in our laboratory. We present the environment variable in the house, home control (such as auto-curtain, illuminator) and monitoring system to users through the browser. Store the data distributed with the JDO interface service based on Google App Engine, and the protocol converter achieves the transition among the ZigBee, Bluetooth and serial port.

The real-time collection of environment variable and the home control system are set randomly. ZigBee nodes use TI CC2430 wireless SOC, install Z-Stack, set Mesh network topology, the refresh time of data is 1s, and the delay of communication among nodes is 60-100ms, conforming to the actual needs. The video capture uses C6000 series digital signal processor of TI. Achieve three functions of protocol converter with the S3C2440 processor provided by SAMSUNG Company, the objects are shown in figure 4.



(a)



(b)

Figure 4. The objects of terminal in house

In the experiment, we build a Web services program of smart home based on Java environment on PaaS of Google

App Engine. Result is shown in figure 5. The experiment confirms the feasibility of smart home based on Cloud Computing; and next step we have to work on security and certificate. So Cloud Computing with unlimited net-resources supplies a uniform management platform for all smart homes. In addition, the platform integrates rich internet resources, will truly be personal intelligent agent.



(a)



(b)

Figure 5. The Web interfaces of smart home based on GAE

The figure 5 shows the application of remote operation to the smart home environment by the browser. The whole smart home space is covered by the Mesh network consisted of seven ZigBee nodes, and the user can get the environment data of each scene, such as temperature, humidity level and illumination, at real-time after he/she log in the browser. Moreover, the platform we designed realizes the double channels video monitoring confederately controlled with the third and sixth node of ZigBee, so it can automatics switch to the corresponding video when we are controlling the curtain and the door, and the users can observe the performance of equipments. We verify the practical applicability of Web services of monitoring for smart home based on Cloud Computing.

V. CONCLUSIONS

We have introduced a novel smart home based on Cloud Computing which liberate the local computers and higher efficient to process numerous data and control the smart home. And for the users, it is convenient to access the information at real time no matter where he/she is. We build the platform to realize the model and provide Web interfaces to users. The experimental results show that it is possible to achieve the smart home based on Cloud Computing, and the platform of Cloud Computing providing limitless network resource, and guarantee the users data security for its

inherent secure environment. In the future, we will devote ourselves to providing multi-user service to the Web proxy on Cloud Computing platform and consummating the safety certificate system for users.

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