

Monitoring System for Integrated Management of IoT-based Home Network

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ABSTRACT

Recently, the society is rapidly becoming highly integrated with the convergence of smart devices, SNS, big data, cloud, and IoT. This phenomenon is being spread more swiftly based on the wired and wireless communication infrastructure provided to most homes, as terminal devices for communication have more various functions and are being supplied to homes through a multi-vendor system and as several terminal devices are installed in each home to provide services. Particularly, various IoT terminal devices and services are being introduced to facilitate functions such as home crime prevention, gas valve control, control of electric apparatus and temperature-humidity sensors, and door control based on facial recognition, and integrated IoT-based management monitoring is required for TVs, washing machines, refrigerators, etc. Hence, in this study, a monitoring system for integrated home network management and data collection management, which solves problems of existing home network systems by connecting API Adaptor connection technology, message technology for integrated management of universal communications terminal devices and IoT devices, and data modelling technology to individual network platforms, was proposed.

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1. INTRODUCTION

Internet of Things (IoT) technology, which connects all the sensors and devices, is evolving based on wireless sensor network technology [2]. IoT is object-space network that forms an intellectual relationship such as sensing, networking, and data processing based on mutual cooperation without explicit intervention of human beings on three distributed environmental elements of people, objects, and services [16]. Objects should be able to create new information by obtaining data by themselves and exchanging it with other objects if needed [17]. To establish a consistent data transfer method between objects, Message Queue for Telemetry Transport (MQTT) protocol that can replace HTTP is being proposed.

In this study, a monitoring system for integrated home network management and data collection management, which solves problems of existing home network systems by connecting API Adaptor interworking technology, message technology for integrated management of universal communications terminal devices and IoT devices, and data modelling technology to individual network platforms was proposed. In this study, relevant research is introduced in Chapter 2, the proposed system is designed in Chapter 3, and conclusions of this study are presented in Chapter 4.

2. RELEVANT RESEARCH

2.1. Open IoT Platform

Open IoT consists of a Planet platform for registering and searching IoT devices, a Mashup platform for obtaining data from IoT devices and providing Mashup services based on the data obtained, a Store platform for providing various IoT applications and Web applications, and a Device platform for generating and obtaining data through connection with various Things [2] [14]. Figure 1 shows the structure of the IoT platform service. Open Internet of Things installs an IoT device and registers it into the Planet platform to provide various services; in other words, the first IoT device is installed in the actual environment and then registered in the Planet platform [10] [11]. The IoT device registered obtains data through the Things connected or transfers data generated or obtained through the IoT device to the Mashup platform.

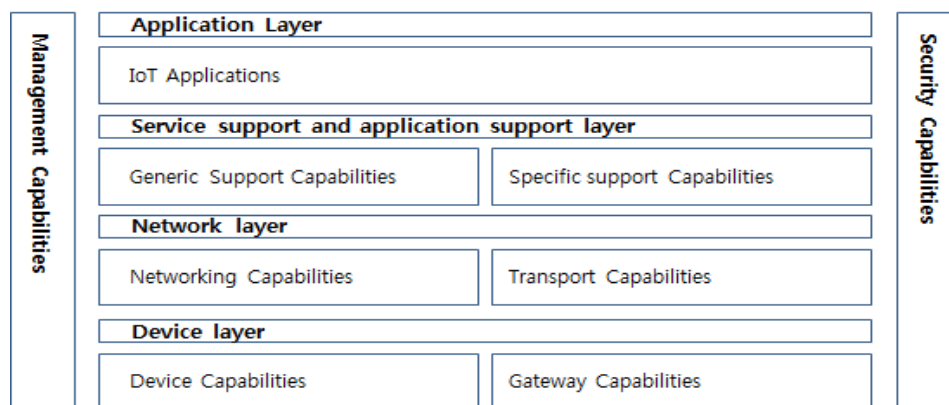


Figure 1. Structure of IoT platform service (ITU-T Y.2060 IoT reference model) [4]

2.2. Smart Home

Smart home refers to an individual house that supports automation and is also called Domotics in the United States. Various automation methods (i.e. control of lighting, temperature, and doors and windows and security system) of intelligent buildings can be applied to home automation, as well as home theater control, automatic, efficient air conditioners, crime prevention systems, and medical system access [1] [5]. These houses are also called intelligent houses or IT houses and serve as a gateway to a ubiquitous-city (u-City) [12]. When applying home automation from the start of house construction, wirings are installed in the walls and connected to a controller for control; wireless technology is also being used.

Technology required for smart home management is developed based on technology of an automation system for managing home terminal devices for communication services. Basic technical requirements for managing home terminal devices can be briefly described as follows [13].

- (1) Standardized management interface technology for home terminal devices in a multi-vendor environment.
- (2) Management information modeling technology for integrated management of various home terminal devices.
- (3) Real-time or semi-real-time data processing technology for data stream, such as collection, classification, storage, and analysis of various event messages output from more than millions of home terminal devices [18].
- (4) Remote firmware upgrade management technology for upgrading firmware of various home terminal devices by using the latest data.
- (5) Network termination test management technology for ensuring connectivity between various terminal devices and network.
- (6) Configuration management technology for immediately opening, canceling, and modifying various home terminal devices.
- (7) Mobile application supply and management technology for real-time handling of on-site tasks related to composition, opening, malfunction, and tests for home site response.
- (8) API supply technology for connection with external systems [3-4].

3. SUGGESTED MONITORING SYSTEM

3.1. Requirement Analysis

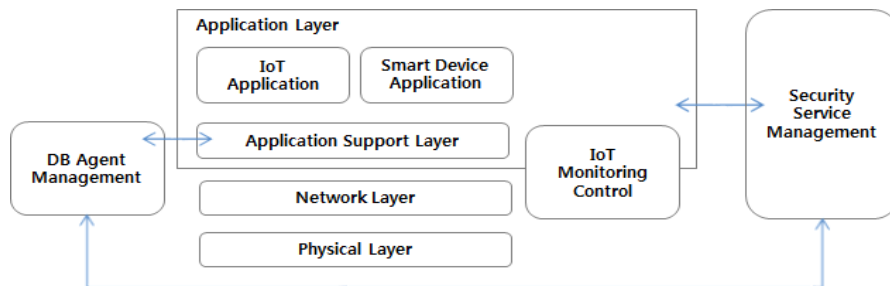
When the home terminal environment evolves to smart home, the home network consists of existing communication devices and home hub, individual IoT terminal devices for single services and their home gateways, and smart IoT home appliance and their home gateways. In addition, each service provider establishes a management system unique to the services they provide according to their own platform for service supply and service management system. Requirements for the management system are as shown in Table 1.

Table 1. Establishment of the smart home management system

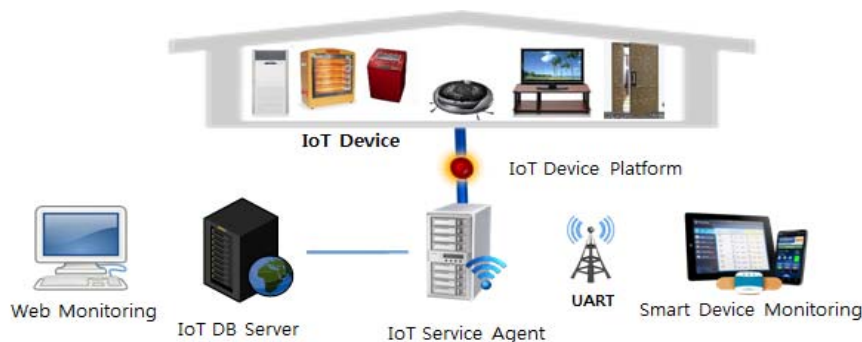
System	Detail	Others
Connectivity	Connectivity of home network that should be established regarding characteristics of remote home services is ensured.	
View	Various home service catalogues can be checked using a 'single mobile app' and home view is provided to customers based on an integrated system and managed.	
Problem experienced by customers	When a customer tries to solve a technical problem or a failure is found in a smart home, a single VoC contact is provided and a single management technical system is required.	
MashUp	IoT MashUp services and an integrated management system are needed in smart home as well.	

3.2. Development Environment

An Android app for IoT-based home network monitoring was developed by installing JDK and Android ADT bundle and using embedded equipment, wireless communication modules, and smart devices (i.e. Galaxy Note IV) [7]. Moreover, information on home control, external control, monitoring, location data acquisition, and a machine to machine (M2M) status was identified and ZigBee, Bluetooth LE, 802.11ah of Sub-GHz, and ZWave were used as the communication modules; this environment is as shown in Figure 2 [6] [9] [15]. The Platform is composed of device registration, application registration, M2M device control, and IoT-based DB.



(a) Service structure



(b) IoT home platform

Figure 2. Platform development environment

3.3. Suggested System

The proposed monitoring system supports various network modes between various smart devices and home appliances where sensors are attached for integrated home network management, as shown in Figure 3. This system consists of home monitoring, external monitoring, and M2M monitoring.

```

//
{
  "RegContextRegistrations": [
    {
      "RegEntities01": [
        {
          "type": "GasRoom",
          "isPattern": "True",
          "id": "Room1"
        }
      ],
      "name": "temperature",
      "type": "float",
      "isDomain": "1"
    }
  ],
  "ProvidingApplication": "http://homelive.com/Rooms-@01"
}
//
{
  "RegEntities25": [
    {
      "type": "LiveingRoom",
      "isPattern": "True",
      "id": "Room2"
    }
  ],
  "name": "temperature",
  "type": "integer",
  "isDomain": "0"
}
],
"ProvidingApplication": "http://homelive.com/Rooms-@25"
}
//

```

Figure 4. Some of the IoT Monitoring System program

In home monitoring, integrated messages and data are modelled for integrated management of terminal devices and IoT terminal devices by connecting individual platforms and APIs of smart devices and home appliances installed with various sensors. In addition, general situations and dangerous or warning situations are monitored and controlled through remote terminal search and control. The payload as some can be the following, as shown in Figure 4.

By extracting and managing common data and applications abstracted through data modeling and application modeling of each home IoT terminal device, data of terminal device management for communications, API data for terminal device control, data of terminal device management according to their types, and API mapping matrixes are derived and managed. In addition, data of home IoT terminal device management, data of upper-level terminal device management, API data for terminal device control, API data for terminal device control based on upper-level terminal devices, data of terminal device management according to types, and control API mapping matrixes are derived and managed.

External monitoring is performed to externally monitor and control the status of smart devices and home appliances installed with various sensors based on a centralized network structure by obtaining cloud data on the IPV6 Internet.

For monitoring, remote terminal search and control are carried out by using the API derived through application modeling of terminal devices of each platform and by using the management objects. Moreover, an API function for integrated command management and control according to terminal types is established for remote search of basic information on the terminal device, remote search of its status data, and individual control of terminal device.

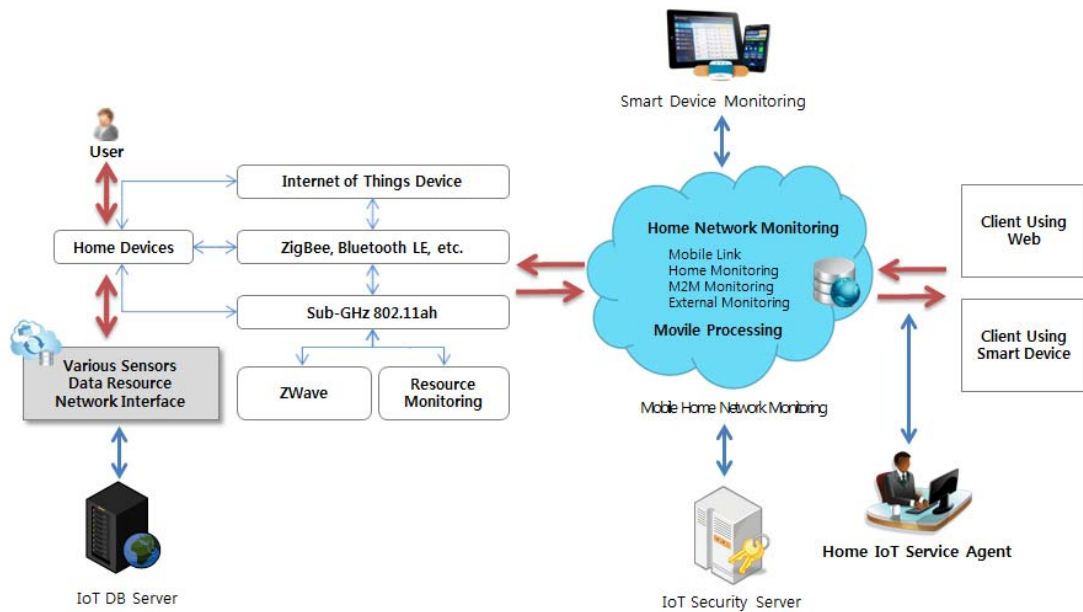


Figure 3. System for integrated home network management

Whereas data exchange was previously performed based on connection of wired and wireless Internet, M2M monitoring facilitates data exchange and analysis through direct communication between devices equipped with sensors and smart devices. Such monitoring is performed for wire and wireless integrated home network management based on diverse connections with All Seen Alliance, OIC, ThreadGroup, and oneM2M, with ZigBee for integrated connection with the IoT platform, and with Bluetooth LE, 802.11ah of Sub-GHz, and ZWave.

4. CONCLUSION

Customers are increasingly seeking integrated management of various devices in smart home. Moreover, the IoT platform for providing smart home services and management functions for integrated management are being standardized rapidly, and the demand is increasing for a standard for managing smart networking terminal devices and services, which are becoming complicated, by developing technology of the integrated management system.

In this study, a monitoring system for integrated home network management and data collection management, which solves problems of existing home network systems by connecting API Adaptor connection technology, message technology for integrated management of universal communications terminal devices and IoT devices, and data modelling technology to individual network platforms, was proposed

In addition, further studies will be conducted to examine the security and safety of open IoT and smart home.

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Chang-Su Ryu received the M.S. degree in 2006 and Ph. D. degree in 2010 from the Department of Electronic Information Security Engineering of Mokwon University, Korea. Since 2014, he has worked in the Department of Cartoon and Game Animation at Yewon Arts University, where he now works as a professor. His current research interests include computer graphics, image processing, animation, game programming, cloud computing, databases, telecommunications systems, Android, mobile, network, virtual environments, and information security.



Change-Wu Hur received his M.S. and Ph.D. degrees in Electrical and Electronic Engineering from the Yonsei University in 1984 and 1991, respectively. From 1986 to 1994, he joined at LG Research Center, where he worked as Senior Member of Technical Staff. In 1994, he joined the department of Electronic Engineering, Mokwon University, Korea, where he is presently a professor. His research interest is in the area of VLSI and Display that includes ASIC design, Display technology and Wireless Communication design.