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# Study on the IOT Architecture and Gateway Technology

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***Abstract*—There are disadvantages in the practical application with Three-layer architecture of IOT (Internet of Things). In order to emphasize the level of IOT intelligent application, this paper introduces the five layers system architecture which can better interpret the meaning and features of the IOT, and discusses the gateway technology which connecting the sensing network and traditional communication network. According to the actual demand of hotel chain industry for improving guests' living environment, the paper also discusses the design of IOT application scheme with using the IOT gateway as a bridge. The scheme may effectively meet the service requirements of hotel chain industry.**

***Keywords-Internet of things;system architecture;hotel chain;gateway technology;IOT application scheme***

## I. INTRODUCTION

Since the Internet of things (IOT) was proposed in 1999, its connotation has been in continuous development and expansion, but there are no uniform definition standards. The IOT concept broadly refers to RFID, infrared sensors, GPS, laser scanners and other information sensing devices, according to the agreed protocol, to achieve any time, any place, any object information exchange and communication in order to achieve intelligent identification, locate, track, monitor and manage a network[1]. The IOT has full perception, reliable transmission, intelligent processing and other features, and the IOT was making extensive use of, and made throughout the wisdom industry, wisdom agriculture, intelligent transportation, smart security, environmental protection, wisdom health care, government livelihood management, intelligent home, food safety and so on.

Although the IOT industry has been in rapid development in recent years, there is still no large-scale applications in reality. there is no uniform construction standards, norms things access and integration management platform[2]. The three-layer framework of IOT is widely regarded, namely, IOT is consisting of perception layer, network layer and application layer. Although the three-layer framework describes the architecture of the IOT from the technical level, but not fully shows the characteristics and connotation of the IOT. Now some applications require the closed-loop system, and the IOT is an open-loop ubiquitous network system, so its application and promotion still faces many difficulties and challenges.

In this paper, we put forward the five-layer framework of IOT that can better explain the characteristics and connotation of the Internet of things, based on the theoretical research of IOT and application in cross-regional chain hotel. In practical application, we realized the cross-regional hotel chain connectivity by using network gateway as a bridge in IOT.

## II. THE FIVE-LAYER ARCHITECTURE OF IOT

Through analyzing the characteristics of the IOT[3], we put forward the five-layer framework of IOT. Namely, IOT is consisting of perception layer, network access layer, network layer, application support layer and presentation layer, as shown in figure 1.

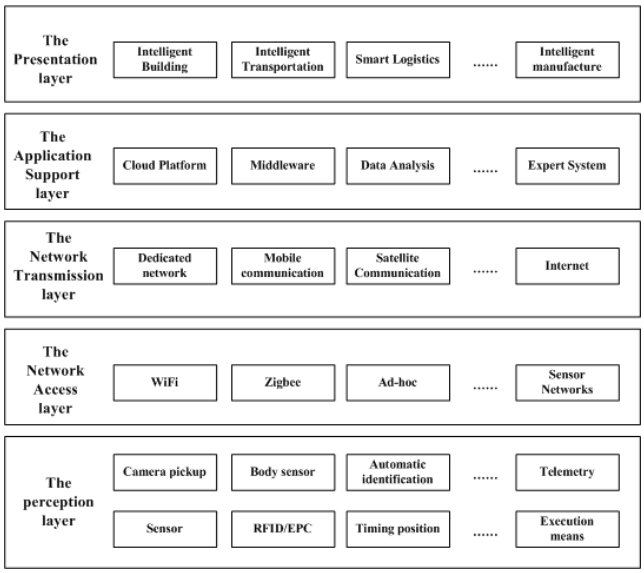


Figure 1. The five-layer architecture of IOT

(1) Perception layer of five-layer architecture: The perceptual layer is the foundation of IOT, is the interface between the layer of physical world and information world. It uses radio frequency identification technology, bar code technology, sensor technology, positioning technology, or other information sampling technology to complete the information collection, and with the help of controlling the objects of perception by the actuator, implement the infection control between the physical space and information space. Its main components include two-dimensional code label, code reader-writer, RFID tags and RFID reader-writer, cameras, and all kinds of sensors. So, The IOT perception layer has the main functions of information perception and original data collection, necessary auxiliary complete downward at the end of the control object. Therefore, the main function of perception layer of IOT is information and

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data collection, when necessary, assist to complete the control objects of perception.

(2) Network access layer of five-layer architecture: The network access layer is mainly composed of the base station node and the network access gateway, complete the network control and the data fusion of each node in the perception layer, or complete to forward the information from the above layers (The network transmission layer or the application layer). When the perception layer's nodes complete networking, the perception layer's nodes need to upload data, and send the data to the base station node. The base station node will receive the data, and complete the connection with the network transmission layer by the access gateway. When the application layer and the network layer needs to downlink data, the base station node sends data to each node in the perception layer after the network access gateway receiving the data from the network transmission layer, then complete the forwarding information and interaction between the perception layer and the network transmission layer. The current access methods in the network access layer mainly include WIFI, Ad hoc, Mesh, ZIGBEE, industrial bus, realize to collect the information by various cognitive tools, or to preliminary process and network access.

(3) Network transmission layer of five-layer architecture: The network transmission layer is mainly used to realize the transmission and exchange of information, provide the basis transmission network for the necessary of applications and services within a wide range, including the satellite communication network, the mobile communication network, the optical fiber communication network and the local independent private network and so on. It is a problem in the network layer that the neutral access and seamless integration between different network and means of communication, and how to form the transmission and exchange capacity with end-to-end .

(4) Application support layer of five-layer architecture: With the support of the information technology with the cloud computing technology, middleware technology, database technology, expert system and so on, the application support layer complete public intelligent analysis and storage of data information, realize information processing, and all kinds of intelligent application sharing and exchanging.

(5) Application presentation layer of five-layer architecture: The application presentation layer's task is the development of a variety of applications of IOT base on the data processing of the application support layer, and uses the technology with multimedia, virtual reality, human-computer interface to build the interface of intelligent application between the IOT and the user, implement present and application of all kinds of intelligent information.

## III. THE GATEWAY TECHNOLOGY OF IOT

The gateway is a network to another network "mark", and the IOT gateway is a connecting link between the sensor network and the traditional communication network, and it can store and convert the interaction data between the network and the traditional communication network. The gateway is between the perception layer, network layer and the network access layer in the five layers of IOT architecture, and the IOT will be able to integrate a variety of access methods, to meet the convergence and access requirements for the local short distance communication, to link to the public transport network and complete the forwarding, controlling, signaling and encoding and decoding functions. At the same time, the gateway is protocol converter, to achieve protocol conversion between two different networks, and then a packet format can be converted to another packet format, and has the function with safety protection and prevent outside intrusion. So, the IOT gateway will have access ability between the WAN, management ability, protocol translation ability, and other major functions[4].

### *A. The IOT gateway hierarchy*

IOT gateway supports a variety of communication protocols and data types between the various sensors, which can realize the conversion of data format which communicated between a variety of sensors, to unified the uploaded data formats. At the same time, the acquisition or control command which reach the perception network are mapped to produce messages that meet specific device communication protocol[5]. The basic structure of the IOT gateway as show in Figure 2, including application layer, network layer, analysis layer (protocol conversion and protocol adaptation layer), perception layer.

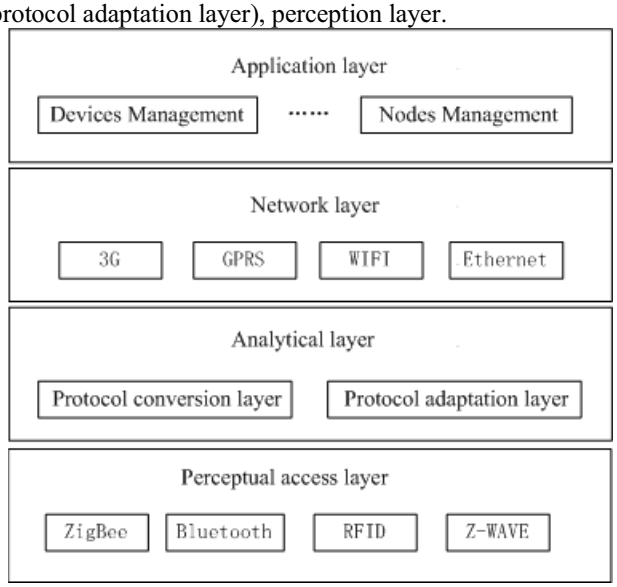


Figure 2. The IOT Gateway Hierarchy

(1) The application layer: The application layer will realize automatic management of sensing device, and the management of each sub network.

(2) The network layer: The network layer provides a variety of channel access communication network interface. For the mobile environment or non fixed environment of the network, you can use a variety of access methods. For the specific network environment of the network, can be used in single access mode. The network layer includes a variety of

communication network and Internet to form network, which is the current mainstream of communication network, such as 2g, 3g, 4g network or a computer Internet, etc.

(3) The analytical layer: The analytical layer will implement the standardization of protocol conversion and data format analysis, including the protocol adapter and protocol conversion module.

The protocol adapter module defines a interface to access standard, ensuring different access layer protocols can become a unified data format and signaling.

The protocol conversion module will be unified packaging the uploaded standard data from the protocol adapter, unpack the data from the network layer into the standard format. And provide the protocol conversion from perception to communication network , namely to implement ZigBee protocol to TCP/IP protocol conversion.

(4) The perceptual access layer: The perceptual access layer will complete the network control and the physical access for nodes, and match a variety of sensor network technology to realize different perception network protocol access.

### *B. The gateway hardware structure*

The IOT gateway is a bridge connecting perception network and access network, it can support different types of sensor nodes (such as ZigBee, 6LoWPAN, RS485, CAN) and the way of access (such as cable, WLAN, GPRS, 3G), and provide a unified data format for middleware or application, in order to shield the different sensor network and the access network, make applications only need to pay attention to in the application environment of data processing.

This paper adopted the modular design concept and embedded system technology to design the IOT gateway, the structure of the IOT gateway is shown in figure 3. The processor module is the core module of the gateway, which implements the protocol conversion, management, security and other aspects of data processing and storage. The zigBee module realize the collection of physical world data or together, can be the convergence of sensor network nodes, the RFID reader, video collection equipment, GPS, etc. Through the network access module, the gateway will access WAN by the way including cable (Ethernet, ADSL, FTT), wireless (WLAN, GPRS, 3G, satellite).

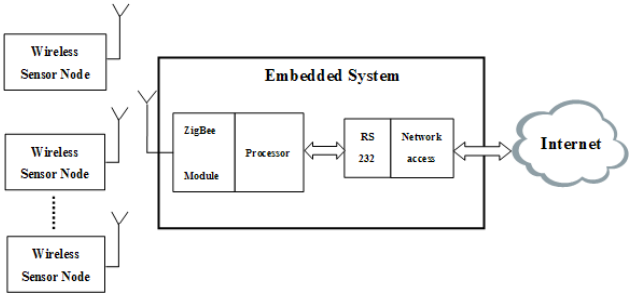


Figure 3. The gateway hardware structure

## IV. THE DESIGN OF THE IOT GATEWAY OF CROSS-REGIONAL CHAIN HOTELS

For chain hotels, to build an efficient and stable cross-regional network management architecture is very important. And how to make the devices (such as air conditioning, television, access control, lighting, etc.) to interconnect, effective sharing of resources and information to facilitate the stay guests, is an important indicator of the quality of service of a hotel. With the development of IOT technology, the IOT gateway technology become more mature, and the equipment in the hotel room connectivity problem will be solved.

The IOT gateway, which is the core equipment of the construction and intelligent of hotel rooms, allows multiple intelligent devices interoperability in the room, forms a local area network, shares resources and information between devices. In addition, the gateway also plays the internal network and the external network interface communication role, providing access and control functions for all kinds of value-added internal network service, which makes the internal rooms network become an extension of the communication network, communication network the internal network to the wide world.

### *A. application architecture*

Based on the study of design for the smart home system [6][7], we put forward a typical cross-regional chain hotels IOT application architecture, as shown in figure 4.

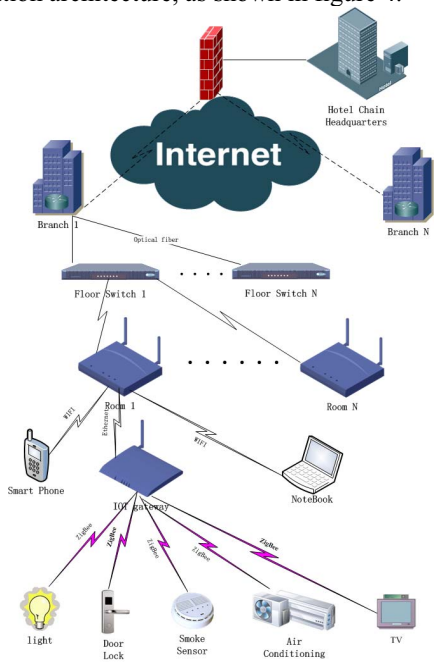


Figure 4. The IOT structure of Cross-regional hotel chain

In the hotel guest room, for TV, air conditioning, access control, smoke detectors, lighting and other equipment, the system will be build their own subnet system respectively, and make the equipment of different protocols or subsystem to communicate with each other through the gateway, and

users only need to operate the gateway to control all intelligent devices connected to the gateway. In addition, the gateway is also integrated with internet access, can carry on the wide-area interconnection with the outside world, the device within the hotel room can be operated and control in any place of the world, then greatly enhance the convenience and applicability.

### *B. the design of the gateway hardware[8]*

In this paper, we use STR912 ARM9 chip which integrated Ethemet (MAC) interface to design the IOT gateway, it mainly includes the embedded ARM processor module, Zigbee protocol module and network access module, the structure is shown in figure 5.

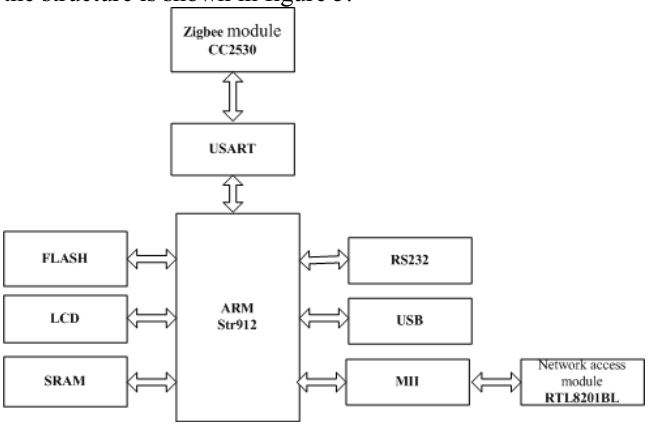


Figure 5. ARM-based processing module structure

The processor module is the core of the gateway, the gateway is responsible for the entire device control, task allocation and scheduling, data integration and so on transmission. Its core chip using ST's STR912FW44. STR912FW44 is one of the latest series of industrial-grade single-chip ARM9 microcontrollers, based on ARM966E-S core, on-chip comes with FLASH, USB, CAN, SPI, Ethernet and other peripherals, with tightly coupled 512KB FLASH memory and 96KB of SDRAM. STR912 works with stable performance, strong compatibility, strong scalability, maintenance reliability, save large data capacity, long time and so on.

The zigbee protocol module uses the CC2530 of the Texas Instruments (TI) , for data communication between the gateway and the sensor nodes, the node is responsible for receiving data. The CC2530 combines a high-performance 2.4GHzDSSS (direct sequence spread spectrum) RF transceiver and a high-performance low-power 8051 microcontroller, used to build the network node with low price, at the same time, it integrated IEEE802 .15.4 standard 2.4GHz band RF transceiver in a single chip, with excellent radio reception sensitivity and immunity.

The network access module is used to the gateway access wan, because STR912FW44 processor module is included within the Ethernet MAC and MII interface, when connected to the Ethernet network , the access module only need to add an Ethernet physical layer (PHY) chip RTL8201BL.

As can be seen from the above analysis, the processor module STR912FW44 mainly receive the data from the zigbee wireless sensor network and realize the data storage and process, and then send the processed data sent to the Internet until the headquarters center server through the network access module( RTL8201BL). At the same time, for some control commands sent by the server center headquarters to process, and transmitt to the nodes of the sensing network. In addition, the gateway can also include a LCD display, buttons and other functional components.

## V. CONCLUSION

The concept of IOT is for a long time, but the specific implementation and composition framework of IOT have not formed a unified opinion. In this paper, on the basis of analysis of practical applications of IOT in life, we analysis lack of research on the three layer system structure, put forward five layers of IOT application system frame of reference, it can better explain the characteristics and meaning of IOT. At the same time, through the analysis of demand, we put forward the solving scheme of cross regional hotel chain of the IOT combined with the technical characteristics of the IOT application, and use the IOT gateway as a bridge to realize exchanges of the hotel rooms information and communication of different equipment, realize the connectivity of the IOT with the Internet, and to meet the needs of the cross-regional chain hotel services.

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